Intensive Training Program for Wastewater Operators in Hawaii Designed to Standardize Professional Outcomes

Mathew Young

Roger Babcock, Jr.

University of Hawaii at Manoa
Civil & Environmental Engineering Department
Water Resources Research Center
May 2013

Executive Summary

Wastewater treatment plants are important facilities that prevent environmental degradation, protect beneficial uses of the waters of the state, protect public health, and often create valuable resources such as recycled water and soil amendments. The success of these wastewater treatment plants is highly dependent on the knowledge, skills, and diligence of the licensed operators who work there. It is essential that operators acquire the knowledge needed to properly operate a wastewater treatment plant through a combination of classroom and on-the-job (OJT) types of training which are not just one-time but continuous throughout the career. In the State of Hawaii, there are 65 different training courses that are available to wastewater operators through the Statewide Wastewater Operator Training Center and many other courses are offered both in person and on-line by a variety of outfits. However, no set program of courses and OJT has been established to serve as a standard for initial wastewater operator training or certification.

For this study, five different wastewater operator certification and training programs from around the United States were evaluated to serve as a comparative basis for creating a training program in Hawaii. The training programs for New Jersey, Georgia, New York, Texas, and California were examined. From the findings, all state wastewater operator programs were found to require training, of some degree, prior to license certification. Except for the State of California, four states required training from a specified outline of general courses that ranged from 6 hours to 225 hours of instruction. The State of California, on the other hand, specified a minimum number of education points (rather than specific courses) which could be obtained through the completion of any combination of a suite of wastewater related training courses.

In the State of Hawaii, there are four levels of wastewater operator licenses; consisting of Grades 1 through 4. Throughout the past five years, Hawaii's operators have had low passing rates on standardized certification examinations at all four levels; with averages of 55%, 42%, 29%, and 15% passing for Grades 1, 2, 3, and 4 respectively. The City and County of Honolulu currently requires that operators obtain their certification licenses within two years of starting work. Failure to obtain a license within two years results in termination, which has been a fairly large problem for new operators and is thought to be due to a combination of insufficient training, mentorship and exam preparation (studying). In addition, survey results of four different wastewater treatment plant facilities on Oahu regarding retirement ages, found that

approximately 72% of the current working operators anticipate retiring within the next fifteen years. Such high retirement expectations, coupled with low certification exam passing rates, have raised significant concerns regarding the sustainability of the wastewater operator profession as a whole. Therefore, a new wastewater operator training program in Hawaii is needed to address this issue.

In this paper, wastewater operator training Boot Camp Programs have been created for the City and County of Honolulu (CCH), to provide a means of standardizing training for the profession of wastewater operators. The new training programs consist of three different options: a 30 Day Boot Camp, a 60 Day Boot Camp, and a 90 Day Boot Camp. Unlike the curriculums of the five states that were researched, the proposed Boot Camp Programs created here, consist of both classroom and hands-on training to provide more complete training. Classroom training programs were formulated to consist of four hours per day during the morning. The major classroom subjects were determined in accordance with the Association of Boards of Certification (ABC) Need-To-Know Criteria for wastewater operator certification exams. A total of nine major training subjects were included in the 30 and 60 Day Boot Camp Programs: Introduction to Wastewater Treatment, Safety, Clean Water Act/Regulations/Permits, Math, Physics, Chemistry, Microbiology, Treatment Methods, and Direct Responsible Charge. There are a total of 80 hours of classroom training during the four week, 30 Day Boot Camp Program, and 160 hours of classroom training during the eight week, 60 Day Boot Camp Program. The 90 Day Boot Camp includes the nine major topics from the 30 and 60 Day Boot Camp Programs plus additional material for a more thorough curriculum option. The 90 Day Boot Camp adds Electricity and Collection Systems, as well as the addition of multiple courses to the Treatment Method section curriculum. The 90 Day Boot Camp Program consists of 240 hours of classroom training, over the duration of twelve weeks. Upon completion of any of the Boot Camp classroom programs, trainees will also receive 10, 20, or 30 CEU's that can aid in fulfilling certification requirements.

In addition to the classroom training, hands-on training sessions are incorporated in all three Boot Camp Programs. The hands-on sessions consist of three hours of training per day in the afternoon that will consist of four major topics: Preliminary Treatment, Primary Treatment, Secondary Treatment, and Solids Handling. A total of 60, 120, and 180 hours of hands-on training curriculum have been proposed for the 30, 60, and 90 Day Boot Camp Programs.

During the hands-on training sessions, trainees will be able to obtain both instructional, as well as hands-on experience, at a wide variety of wastewater treatment plant facilities to ensure knowledge acquisition in all facets of operations and different treatment operation variations.

Assuming the availability of adequate resources, the 90-Day Boot Camp is the recommended version because it packs the most punch in the sense that it covers the most material, in the most depth, and still completes the whole thing in 3 months. It seems clear that highly qualified and motivated operators would emerge from the 90-Day Boot Camp and it further seems like a fairly small investment for an employee that the CCH hopes to have for 40 years. This paper aims to set a foundation for future training studies and measures to be applied at CCH and the entire State of Hawaii. Through implementation of the created training programs, significant strides can be made to enhance the wastewater operator profession in Hawaii.

Acknowledgements

We would like to thank City and County of Honolulu wastewater operators Wayne Salas, Jonathan Baker, Hermen Tomboc, Mike Wymark, and Sonny Awai for their time and help.

Contents

1.0 Introduction

Wastewater treatment is vital for maintaining environmental quality and protecting public health. Treatment plants remove and stabilize the contaminants present in wastewater and produce effluent safe for reuse or discharge to waters of the state. These facilities include physical, chemical, and biological treatment processes. If wastewater is not properly treated prior to discharge, there can be detrimental effects to the health of the environment as well as the public. Effective and efficient wastewater treatment will always be a prominent issue. Wastewater is generated from a variety of origins including household wastes from toilets, showers, baths, and kitchen sinks as well as commercial and industrial sources. Treatment of wastewater can involve four stages: preliminary treatment, primary treatment, secondary treatment, and tertiary treatment plus solids treatment processes. In the preliminary phase of treatment, influent wastewater is screened to insure that trash, fibrous materials, large objects, and grit are removed. Some examples of such unwanted objects include plastic, rocks, and rags. In the next phase, primary treatment, settling tanks are used to separate settleable and flotable solids from the wastewater. Primary clarification is conducted by utilizing the force of gravity to aid in the separation of solids; resulting in lighter materials floating on the top as scum and heavy solids settling to the bottom as sludge. The scum can include an array of things including soap, plastic, oil, and grease. Through the use of rotating scrapers, the scum and the sludge solids are removed from the wastewater and undergo additional treatment.

During the secondary treatment phase, microorganisms are used in a biological process to convert dissolved and colloidal organic materials remaining in the primary effluent into settleable flocculant solids. Filtered air is pumped into the wastewater during this stage to supply the microorganisms with oxygen for metabolism. The microbes consume the organic materials and coagulate together into flocs that settle in secondary settling tanks as sludge. The secondary sludge undergoes additional treatment and the clarified wastewater can be treated further or be discharged as secondary effluent following disinfection. Disinfection is a chemical process in which ultraviolet light or an oxidant such as chlorine is added to the wastewater in order to kill pathogens. The final stage, tertiary treatment, is often used to further improve the quality of the wastewater for recycling or discharge into sensitive environments. During this stage, the liquid wastes that were separated during the secondary process are treated using various filtration and/or biological methods to further reduce effluent suspended solids and/or remove nutrients

nitrogen and phosphorus and/or dissolved salts to improve the finalized effluent quality. After this type of treatment, although the water is not potable, it can be used for irrigation as well as certain industrial uses. In addition to the liquid stream wastewater treatment processes, the various screenings, grit, scum, primary and secondary sludges must be treated in solids stream treatment processes which can also include advanced treatment to produce biosoilds suitable for recycling. The treated effluent and stabilized solids must also be properly disposed. Liquid effluent disposal can include discharge into the ocean, streams, lakes, or underground injection wells. Solid wastes can be recycled as soil amendment or disposed of at a landfill.

Because there are a variety of different treatment processes and operation/maintenance tasks associated with them, it is essential to ensure that wastewater treatment plant operators are sufficiently trained and mentored. During treatment, difficulties, failures and emergencies can arise for a variety of reasons. However, according to the Journal of Environmental Management article "Sustainability of Wastewater Treatment Technologies" (Muga and Mihelcic, 2008) many plant failures that occur at wastewater treatment plants are associated with a lack of specialized operators. This deficiency in specialized operators is often a direct result of insufficient training and comprehension of the wastewater treatment processes. "Results of an EPA survey of 150 small treatment plants with debilitating problems, show that poor operator understanding and application of process control is the most frequently occurring problem that limits treatment plant performance." (Muga and Mihelcic, 2008).[32] By obtaining sufficient training, wastewater operators can significantly enhance their ability to successfully operate a treatment plant facility.

2.0 Objective and Scope of Work

The objective of this paper was to develop an intensive training program for the City and County of Honolulu designed to standardize the professional outcomes of wastewater operators. In order to achieve this, the scope included the following: 1) review of the current wastewater operator certification program for the State of Hawaii, to provide a basis for operator training; 2) evaluation of wastewater operator certification and training programs from five different areas around the United States as a comparative basis for the new training program; 3) review of the Association of Boards of Certification (ABC) Need-To-Know Criteria for operator certification examinations to help decide on classroom topics; 4) review of current training courses available in Hawaii at the Statewide Wastewater Operator Training Center to determine what material

could be used; 5) use the compiled review data and new ideas to create a set of three different rigorous wastewater operator training programs of different duration for the City and County of Honolulu. Additionally, issues pertaining to low certification exam passing rates, operator recruitment, and operator retirement are also described.

3.0 Hawaii Wastewater Operator Certification Levels and Requirements

In the State of Hawaii, the wastewater operator certification process is regulated by the Department of Health, Wastewater Branch in HAR 11-61, through the Board of Certification of Operating Personnel in Wastewater Treatment Facilities (BOC). The BOC grants four different levels of wastewater operator licenses: Grade 1, Grade 2, Grade 3, and Grade 4. For each grade level, there are a set of requirements that must be met prior to applying to take a certification exam for a permanent operator license. If operators do not possess a permanent license upon hiring, they are given a temporary certificate that is valid for two years. During this time, operators must meet a set of pre-certification requirements required to qualify to take the certification exam, and then successfully receive a passing score of 70 or higher. Temporary licenses are not renewable. Failure to obtain a permanent license within two years of possessing a temporary certificate results in termination in the City and County of Honolulu (but not in the other counties). A significant portion of the prerequisites for wastewater operator licensing consists of Continuing Education Units (CEUs). In Hawaii, a CEU is equivalent to eight hours of formal instruction or training, and can be obtained in numerous ways; such as formal in-person training courses or workshops, attending conference lectures, or completing on-line courses. There are minimum CEU requirements that have been incorporated into the Hawaii wastewater operator certification process. However, CEU's are not necessary for certification but they can be used to decrease experience requirements to qualify for examinations and are required for renewal of all licenses (2 CEUs every 2 years).

Grade 1 level wastewater examination applicants must have a high school diploma or equivalent and do not have any CEU requirements. An acceptable equivalent can consist of either a GED or CEUs. Six CEUs can be substituted for each uncompleted year of school through grade 12. Grade 1 wastewater examination applicants must also have at least 12 months of full-time operating experience. Operators can qualify for a Grade 2 license, without obtaining any CEU's, if they have 1 ½ years of operating experience while in possession of a permanent Grade 1 license. Operators can also substitute CEUs for experience. Operators can qualify for a

Grade 2 examination with a high school diploma or an equivalent substitute, at least six CEUs, and two years of full-time operating experience. The amount of required CEU's can vary depending on the amount of operating experience applicants have. The highest amount of CEU's that are required for Grade 2 certification is 22 points, with one year of operating experience. It is interesting to note that the relationship between operating experience and CEU requirements is inversely linear. The greater the amount of operating experience, the less the amount of CEU's that are required to qualify to take a certification examination. Appendix F contains a detailed table of CEU and experience requirements.

Wastewater operators pursuing a Grade 3 license can qualify in three different ways depending on their previous education and experience. Grade 3 examination applicants are not required to obtain any CEU's with 2 ½ years of experience while in possession of a permanent Grade 2 license. Grade 3 applicants are also exempt from any CEU requirements if they possess an Associate's Degree and two years of operating experience. Qualifications for an Associate's Degree include two years at an accredited university or college with fifteen units of basic science OR fifteen units of basic science from an accredited community college. Grade 3 applicants can also qualify with a high school diploma or an equivalent, three years of operating experience, and a minimum of sixteen CEUs (or more CEUs and less experience, see Appendix F).

Grade 4 examination applicants also have three paths to qualify based on their education and experience. If Grade 4 applicants can qualify with no CEUs and four years of experience while in possession of a permanent Grade 3 license; no CEUs with an Associate's Degree and two years of operating experience; a Bachelor's Degree and one year of operating experience; or a high school diploma, 34 educational points, and five years of operating experience (or more CEUs and less experience, see Appendix F) Operators must have obtained their Bachelor's Degree from an accredited university or college with a major related to wastewater treatment.

4.0 Existing Wastewater Operator Training Program in Hawaii

The Statewide Wastewater Operator Training Center (SWOTC) conducts the State of Hawaii's current wastewater training program. There are 63 different courses that the training center currently offers, supporting 460 wastewater treatment plant operators. On an annual basis, about 72 training sessions are conducted and accommodate approximately 575 registered participants. The training sessions that are offered by SWOTC, are open to anyone who wishes

to enroll. Training courses provided by SWOTC include basic, intermediate, and advanced training topics directly relating to wastewater treatment. Operators are also able to obtain CEU's and via approved on-line courses, workshops and conferences. Information regarding course descriptions and topics can be found online at http://hawaii.gov/health/environmental/water/wastewater/pdf/course-descriptions.pdf. Currently, there is no specific set of required training courses that operators must complete prior to obtaining certification. Thus, operators can choose any combination of approved courses.

5.0 Duties of Wastewater Operators

The tasks and duties expected of an operator vary with the Grade of license, with higher grades requiring more and higher complexity capabilities. In general, some of the tasks of an entry level, un-licensed operator include: working while standing, walking for extended periods of time, squatting, climbing stairs, and performing wastewater treatment related tasks. Some of the general Grade 1 operator duties include performing wastewater treatment plant and sewer maintenance duties, working independently in the absence of supervision, and communicating clearly; both orally and in writing. Duties of a Grade 2 wastewater operator can include the following: operate and maintain wastewater treatment plants, record readings from meters, gauges, and other recording devices, interpret data, and inspect plant equipment. Grade 3 level operator duties can consist of being in direct responsible charge and operation of a Class 3 wastewater treatment plant, as well as participation in major repairs, overhaul, and installations of treatment plant equipment. Some of the duties of Grade 4 wastewater treatment plant operators include independently operating and maintaining a Class 4 or lower wastewater treatment plant, as well as participation in the major overhaul, repair, and installation of treatment plant equipment. Clearly, increased responsibility exists higher Grade levels. Particularly upon reaching Grades 3 and 4, operators are required to have a much more thorough understanding of process controls of plant operations, as well as possess the ability to make parameter adjustments when necessary. It is important to note however, that the specific duties at all grades of operation can vary significantly amongst different wastewater treatment plants due to different equipment and processes.

6.0 Problems with the status quo

Some of the major current problems for wastewater treatment plant owners and operators in Hawaii are low certification passing rates, expected retirement ages, and recruitment. A total of 169 wastewater operator certification exams were administered in the August 2011 and February 2012 exam cycle. Out of the 169 examinees, 45%, or 73 operators, passed their exams. Such low passing statistics are not new and have been a prevalent issue for many years. In the past five years there has been a wide fluctuation of passing rates for all four operator grade levels. Grade 1 operator passing rates have varied from 27% to 80%, Grade 2 passing rates have ranged from 24% to 67%, Grade 3 passing rates have varied from 8% to 57%, and Grade 4 exam results have ranged from 0% to 50% passing. Overall, the Grade 1 and 2 exams have often produced higher passing rates than that of the Grade 3 and 4 exams, with overall passing rate averages of 55% and 42%, respectively. The overall certification exam passing rate averages for Grade 3 and 4 licenses were 29% and 15%, respectively. One reason the large difference in passing percentages between Grades 1 and 2 and that of Grades 3 and 4, is the complexity and breadth of the advanced knowledge that is required for Grade 3 and 4 operators. This advanced knowledge includes maintenance and operation of a wide array of wastewater treatment plant processes. The low initial passing rates (Grade 1 and 2) suggests that operators are not obtaining sufficient training and/or specific exam preparation assistance during the beginning phases of their careers and the even lower passing rates for Grades 3 and 4 suggest that ongoing training/preparation is also insufficient.

Currently, Hawaii does not mandate any formal, classroom-type or on-the-job mentorship-type training requirements prior to wastewater operator certification. As a result, many operators are not able to obtain the proper knowledge necessary to pass their certification exams. When an operator is hired by the City and County of Honolulu, he or she receives a temporary certificate that is valid for two years. One condition of this certificate being issued is that the supervisor (DRC) must submit a training plan to the Board of Certification detailing a program to help the operator prepare for the certification exam. Within these two years of certificate validity, operators must be able to obtain their operator license by meeting any pre-certification requirements, as well as by passing their corresponding certification exam. If operators are not able to pass their certification exams within two years however, they are terminated. Such an issue has become relatively prevalent amongst operators due to the

deficiency in operator training. Not only is this a loss of valuable time invested in attempting to develop an operator, it is also a loss for the operator workforce. With the current training program, approximately six to seven years of work experience is necessary to develop quality operators. That is a tremendous amount of time, as well as resources, that are spent strictly towards developing an efficient operator. Likewise, a lack of training enforcement can also create low standardization perceptions of operators in Hawaii. Since there are no set standards for wastewater operator training in Hawaii, it is difficult to convey the importance and seriousness of the operator profession as a whole.

Another problem that exists is the possibility of an operator shortage in the near future. In 2005, the American Water Works Association (AWWA) published the report "Succession Planning for a Vital Workforce in the Information Age" which projected a 32% loss of wastewater utility workers as a result of retirement age eligibility. Research that was conducted by the AWWA and the Water Research Foundation in 2010 found that such projections remained valid; projecting a 30% to 50% loss of water/wastewater utility workers within the next ten years. In the AWWA article "A Regulator's Perspective on Workforce Issues: Water and Wastewater Operators", results of a survey of New York State's small water system operators, pertaining to age and retirement confirmed such statistics. Based on the results, approximately 43% of the operators who were surveyed expected to retire in less than ten years. This problem of operator shortage is also a major concern in Hawaii.

In 2012, in the State of Hawaii, there were 405 operators with permanent licenses for Grade's 1 to 4. However, this number is anticipated to decrease in the near future due to retirements. According to Wayne Salas, Wastewater Treatment Plant District Superintendent for the City and County of Honolulu, many of the wastewater operators who are being hired, are those who were previously retired from Pearl Harbor or other professions, and only intend to work short term in this, their second career. In a survey conducted by Wayne Salas, wastewater operators from four different wastewater treatment plant facilities were surveyed inquiring their age, starting date, number of years of service, and their expected retirement age. The four wastewater treatment plant facilities included Sand Island, Paalaa Kai, Wahiawa, and Waianae. Based on the results, the average age of operators was about 50 ½ years and the average retirement age was about 64 years. In addition, approximately 40% of the operators who were surveyed expected to retire in less than 10 years. Even more staggering, however, are the 72% of

surveyed operators who expect to retire within the next 15 years or less. If such numbers remain valid, almost three fourths of the operators working at Sand Island, Paalaa Kai, Wahiawa, and Waianae will be lost to retirement in the near future.

In addition to the projected operator shortage, supervisor shortages are also a major concern. The time frame to develop a quality operator is approximately six to seven years, upon which time they can qualify for a supervisor position. With the expected loss of supervisors in the near future, there is great concern in regards to fulfilling these supervisor positions, especially if the viable candidates are operators who expect to retire within just a few years after possible promotion. It is impractical and inefficient to develop operators for six or seven years with Hawaii's current training program, especially if they plan to retire within ten or fifteen years. Continuing to do so would only create probable operator shortages in the future. Therefore, training implementations and standards must be created to address such issues. Additionally, enhancements in recruitment must also be made to hire younger individuals to provide a sustainable operator workforce.

7.0 ABC Wastewater Operator Exam Specifications

The State of Hawaii utilizes the Association of Boards of Certification (ABC) wastewater exams for operator license certification. The wastewater operator exams are designed to measure the minimum competency required for an operator at each designated grade level. Each exam consists of 100 questions that are developed by ABC. The 100 questions on each grade level exam are chosen by Hawaii Board of Certification, from a total of 200 questions forwarded from ABC. A minimum score of 70% is required for passing each exam. According to ABC's Need-To-Know Criteria, all certification exams test operator competence in the following topics: evaluate physical characteristics of waste stream; perform security, safety and administrative procedures; evaluate and maintain equipment; operate equipment; monitor, evaluate and adjust treatment processes; and laboratory analysis. The ABC Need-To-Know Criteria consists of numerous wastewater operator guidelines and specifications that were determined through the analysis of task surveys, as well as operator performance ratings, most recently updated in the year 2010. Through the analysis, a set of wastewater treatment operator core competencies were identified. For each of the certification grade level exams, percentages of questions from each major section are provided. For the Grade 1 examination, 5% consists of evaluation of physical

characteristics of waste stream, 11% consists of performing security, safety, and administrative procedures, 28% of the exam consists of evaluating and maintaining equipment, 16% of the exam consists of operating equipment, 33% of the exam consists of monitoring, evaluating, and adjusting treatment processes, and 7% of the exam consists of laboratory analysis. Classes 2, 3, and 4 also follow a similar but slightly different pattern in percentage distribution of the six major topics. One interesting note is the percentage that the three predominant topics "evaluating and maintaining equipment", "operation of equipment", and "monitoring, evaluating, and adjusting treatment processes" comprise in the exams. For Class 1 operator exams, these three major sections comprise of 77% of the bulk of the exam, 76% for Class 2 exams, 78% for Class 3 exams, and 78% for Class 4 exams. These large percentages are important to note because they indicate focus areas for an effective training program. A complete breakdown of ABC's Need-To-Know Criteria is contained in Appendix J.

8.0 Process of Selecting Five States for Training Comparison

Five wastewater operator training programs were chosen for evaluation to determine characteristics, trends and potential best practices as input to creation of a new training program in Hawaii. During the research process, numerous states were studied to identify programs which contained structured training curriculums. This research found that most programs provide little or no training, and for a few others we could not determine the details of training programs that were provided. The states of New Jersey, Georgia, New York, Texas, and California were chosen based upon availability of information and the relatively formal nature of their wastewater operator training programs. These five programs were also chosen to provide a spatially distributed representation of training programs across the United States.

8.1 New Jersey Wastewater Treatment Plant Operator Training

There are various types of licenses in the State of New Jersey for Wastewater Treatment System Operators. Each type of license has a set of requirements that must be met prior to certification. The two different types of licenses that are associated with wastewater treatment include workers at Public Wastewater Treatment System (S License) and workers at Public Wastewater Collection Systems (C License). For each of these two categories, there are four corresponding grade levels. Depending on the applicant's level of background education, there are numerous ways in which an operator can qualify for a license examination. However, unlike

Hawaii, for both categories of licenses, applicants must successfully complete the Introductory Course approved by the New Jersey Department of Environmental Protection (NJPED) prior to taking any examination. Applicants can only avoid this requirement if they possess a post-secondary degree (college degree). The New Jersey Introductory Course consists of two parts, with a total of 135 hours of training. For comparison, a semester-long, 3 credit college course, consists of 135 hours of instruction.

Part I of the Introductory Course includes five major subjects of training for a total of 90 hours. The five subjects include Mathematics, Physics, Chemistry, Microbiology, and Miscellaneous. The Mathematics section encompasses 36 hours of training; including basic math, basic algebra, and geometric figures. The second section, Physics, focuses on hydraulics, electricity, and simple machines for a total of 26 hours of training. The next subject, Chemistry, comprises of 11 hours of basic chemistry training topics such as atomic structures, elements, compounds, and balancing equations. The fourth section, Microbiology, includes eight different topics of training for a total of 11 hours. The topics covered in this section include cell structure, cell metabolism-reproduction, and typical microorganisms related to wastewater. The last section of training, for Part I of the Introductory Course, covers Miscellaneous topics for a total of 6 hours. These topics include terminology, laboratory equipment, and basic laboratory methods. There are also at least two tests that are given throughout the Part I course, on which a minimum of 70% is required for passing.

Part II of the Introductory Course includes six main sections for a total of 45 hours. The first section covers Administrative topics for 4 hours, including review of rules and regulations as well as reporting to regulatory agencies and safety. The second section consists of 2 hours training pertaining to Wastewater Sources and Characteristics included domestic, industrial, parameter ranges, and flows of wastewater sources and characteristics. The third section covers Treatment Methods for a total of 25 hours. This is broken down into preliminary treatment (three hours: screening, grit removal, comminution, grinders, pre-chlorination and pre-aeration), primary treatment (three hours: septic tanks, imhoff tanks, clarifiers and chemical precipitation), secondary treatment (ten hours: trickling filters and RCB's, activated sludge, step-aeration, and secondary clarification), sludge handling (six hours: thickening, digestion, and disposal), and advanced treatment (three hours: ammonia removal, phosphorous removal, and stabilization lagoons). The fourth section includes 2 hours of training on Disinfection including the types of

chlorination, methods of application, and dechlorination. The fifth section covers 3 hours of Wastewater Analysis and Interpretation including process control and laboratory testing of BOD, suspended solids, sludge analysis, and other analyses. The sixth section covers Collection Systems for 6 hours, including gravity systems, pumping stations and force mains, pretreatment, and safety topics. Once these sections have been completed a cumulative examination is taken. The final part of this training session includes a 3 hour field trip.

The State of New Jersey also has an advanced training course for wastewater operators. In order to obtain a Class 2, 3, or 4 license, the advanced course approved by the NJPED must be completed. The New Jersey Advanced Wastewater Operations Course consists of eight major sections of training. Section I consists of 15 hours of Administrative training, including rules and regulations, NJPDES permits, sludge reports, lab certification, preparing monthly reports on plant operation, budgeting, importance of continuing education (attending conferences and seminars), and utility management. Section II consists 1 hour of Wastewater Sources and Characteristics. Section III contains 27 hours on Treatment Methods, including three hours of preliminary treatment, three hours of primary clarification, and twenty one hours of secondary treatment. Section IV consists 22 hours on Sludge Digestion and Solids Handling, including sludge thickening methods, sludge digestion, sludge dewatering, and sludge disposal. Section V contains 11 hours on Advanced Treatment, including stabilization lagoons, nitrification, denitrification, and phosphorous removal. Section VI consists of 3 hours on Disinfection, including types of disinfection, methods of application, and dechlorination. Once this section of training is completed, a three hour field trip is taken. Section VII consists of 8 hours on Laboratory Analysis and Operation Control, including BOD, COD, ammonia, total Kjeldahl nitrogen, TOC, DO, pH, chlorine residual, phosphorous, sludge analysis, and other topics. The advanced wastewater training course includes a final cumulative tes, with a minimum score of 70% required for passing.

In addition to completing the required training courses, applicants for a Class S1 or C1 license are also required to have a minimum of a high school diploma or equivalent certificate, as well as one year of operating experience. Applicants, who seek to obtain a Class 2, 3, or 4 S or C license, are also required to meet the minimum education and experience requirements, in addition to completing New Jersey's Advanced training course. For Class 2 licenses, applicants must possess a high school diploma or equivalency certificate as well as three years of operating

experience. However, if the applicants have higher education degrees, the experience requirements decrease. Applicants who have an Associate's Degree in engineering or a related science are required to have two years of operating experience. Those who possess a Bachelor's Degree in engineering or a related science are required to have only 1½ years of operating experience. Class 3 license applicants also contain different pathways depending on the applicant's educational background. License 3 applicants must meet one of the following combinations: a high school diploma or equivalency certificate, three years of operating experience, and three years of direct responsible charge experience, OR an Associate's Degree, two years of operating experience, and two years of direct responsible charge experience, OR a Bachelor's Degree, 1½ years of operating experience, and 1½ years of direct responsible charge experience. Class 4 license applicants also have three different path options to choose from. Class 4 applicants must meet one of the following combinations: possession of a high school diploma or equivalency certificate, six years of operating experience, and four years of direct responsible charge experience, OR an Associate's Degree, four years of operating experience, and three years of direct responsible charge, OR a Bachelor's Degree, three years of operating experience, and two years of direct responsible charge experience. Appendix A contains detailed tables pertaining to New Jersey's wastewater operator requirements and training.

8.2 Georgia Wastewater Operator Training

There are four different wastewater certification levels in the State of Georgia as follows, from lowest to highest classification: Class 4, 3, 2, and 1. These four licenses must be obtained sequentially and therefore, require every operator in the State of Georgia to start at a Class 4 or Class 3. There is a set of education, experience, and training requirements that must be met. The State of Georgia provides a wastewater operator training program that consists of ten different courses intended for various levels of training. The ten courses are as follows: 1-Day Course, Class II Wastewater Treatment, Class III Wastewater Treatment, Class IV Small Wastewater Treatment, Industrial Wastewater Treatment, Wastewater Math Part I, Wastewater Math Part II, Activated Sludge Part I, Activated Sludge Part II, and Collection Systems Operation & Maintenance. The State of Georgia does not require applicants to complete all of these courses. Out of the ten courses listed, three can be used to aid in fulfilling Class 4, 3, and 2 level training requirements (Class IV Wastewater Treatment, Class III Wastewater Treatment, and Class II

Wastewater Treatment). The Class IV Small Wastewater Treatment Course serves as an introductory course on wastewater, emphasizing biological pond systems and is intended for those who are working at a biological pond system and wish to become a certified Class 4 operator. This course is 6 hours long and is completed in one day. The Class III Wastewater Treatment Course also serves as an introductory course on wastewater, and includes an overview of the operation and maintenance of wastewater plants, as well as different wastewater treatment processes. The course is 40 hours long, is completed in five days, and is intended for employees who require a refresher course and those preparing for the Class 3 exam. The Class II Wastewater Treatment Course is an in-depth review of wastewater processes and operations. The course is 24 hours long, is completed in four days, and is intended to serve as a refresher course and for those preparing for Class 2 or 1 exams. If exam applicants choose to utilize different training courses than the State courses, they must meet the same amount of coursework hours for each applicable class level.

In addition to the required coursework hours, education and experience criteria must also be met. Class 4 exam applicants must possess a high school diploma or GED certificate, six hours basic water operator coursework, and one month of operating experience. The set of training and operating experience is the same for applicants who possess an accredited Associate's or Bachelor's Degree. Associates or Bachelors Degrees must be in Biology, Chemistry, Engineering, or an equivalent Degree to qualify. At the next level of certification, Class 3 exam applicants are required to have a minimum of a high school diploma or GED certificate, forty hours of basic water operator coursework, and three months of operating experience. The set of training and operating experience also remains the same for applicants who possess an accredited Associate's or Bachelor's Degree. Class 2 exam applicants, however, do have a change in operating experience requirements in relation to the applicant's educational level. If the Class 2 applicant possesses a high school diploma or GED certificate, they must obtain 48 hours of advanced water operator coursework, as well as 24 months of operating experience. If the applicant possesses an Associate's Degree, 48 hours of advanced water operator coursework training and 18 months of operating experience are required. If the applicant possess a Bachelor's Degree, 48 hours of advanced water operator coursework and only 12 months of operating experience are required. Class 2 operator applicants are also required to possess a current Class 3 operator certificate. Class 1 wastewater operator applicants

do not have any additional training requirements and are only responsible for meeting the required operating experience. The three options of operating experience based on education, are as follows: applicants who possess a high school diploma or GED certificate must have 36 months of operating experience, applicants with an Associate's Degree must have 30 months of operating experience, and applicants with a Bachelor's Degree must have 24 months of operating experience. Additionally, Class 1 exam applicants required to possess a current Class 2 operator certificate. Appendix B contains detailed tables regarding Georgia's wastewater operator requirements and training.

8.3 New York Wastewater Operator Training

There are four levels of wastewater operator certification in the State of New York. From highest to lowest, the operator levels are: Class 1, 2, 3, and 4. All wastewater operator exam applicants must meet specified educational and experience criteria, and complete required training. There are four options for the education requirements. Applicants for all exams, are required to have at least a high school diploma or GED certificate (minimum education level). The next education level is the Associate in Applied Science Degree level for which applicants must have received an AAS degree from a duly accredited university or school, along with eighteen months of operating experience at a wastewater treatment plant. The next education level is the Approved Associate in Applied Science Degree level for which applicants must have received the ASS from a duly accredited university in one of four approved curriculums. The four curriculums approved by New York State Department of Environmental Conservation (NYSDEC) include: Ecology and Environmental Technology from Paul Smith's College, Water Quality Monitoring from Ulster County Community College, Environmental Technology from SUNY-Morrisville, and Water/Wastewater Technology from Crowder College. The highest education level option, Bachelor of Science, must have obtained a degree from a duly accredited university or school in a major that included at least thirty credit hours of math and/or science.

The New York wastewater operator training program contains a progressive structure; requiring operators to complete each level of training courses prior to ascending grade levels. There are four training courses that wastewater operators are required to take: Home Study Introductory Course or Basic Operations Course, Laboratory Proficiency Course, Supervision & Technical Operations Course, and Management Course. However, if applicants seek to also obtain an activated sludge license, they are required to take an additional Activated Sludge

course. The required training hours, including activated sludge applicants, ranges from a minimum of 60 hours to a maximum of 170 hours.

Class 1 level operators do not have any variances in relation to educational requirements options and experience. At all levels of education, Class 1 applicants are required to obtain six months of approved operating experience that can be acquired at any wastewater treatment plant. In addition, Class 1 applicants are required to complete either the Home Study Introductory Course or the Basic Operations Course. The Home Study Introductory Course consists of three different options of training. The first section of training is the California State University "Operation of Wastewater Treatment Plants" Volumes I & II. The Operation of Wastewater Treatment Plants Volume I is intended to train operators to effectively and safely operate and maintain wastewater treatment plants. This course can account for nine CEUs and must be completed within six months of starting employment. The Operation of Wastewater Treatment Plants Volume II is a continuation of the first volume and can account for nine CEUs. Similar to the first volume of training, Volume II must also be completed within six months of startup. The second option of training also originates from California State University as well and comprises of "Small Wastewater System Operation and Maintenance" Volumes I & II. The Small Wastewater System Operation and Maintenance Volume I and II are intended to train operators in the daily duties of safe operation and maintenance of small wastewater treatment plants, collection systems, and effluent discharge systems. These courses count for nine CEUs each and must be completed within six months of starting employment. The last option of training for Class 1 operators is "Wastewater Treatment Plant Operation" by the University of Florida. Students can obtain fifteen CEUs from this course which includes two full days of review, in preparation for the state certification exam. The topics that are discussed in this course include wastewater math, rules and regulations, activated sludge and attached growth, troubleshooting, disinfection, aerobic and anaerobic digestion, safety, laboratory, and maintenance.

The Basic Operations Course includes four options of training and can be taken as an alternative to the Home Study Introductory Course for Class 1 exam applicants. There are four approved providers of this training, including: Basic Operations Course approved by NSDEC, New England Interstate Environmental Training Center "Wastewater Treatment Technology", Crowder College Water/Wastewater Treatment Technology Department, and Southern Illinois University at Edwardsville Environmental Resource Training Center. An example of a Basic

Operations Course provider approved by NSDEC is Morrisville State College. Morrisville State College provides 60 hours of training for this course over a span of 12 days. Course topics include: Introduction to Wastewater Treatment, Preliminary and Primary Treatment, Biological Treatment, Fixed Film Biological Treatment, Suspended Growth Biological Treatment and Advanced Treatment, Clarifiers and Disinfection, Introduction to Solids Handling, Solids Stabilization and Disposal, Maintenance and Safety, Sampling, Analysis and Data Handling, and Management and Supervision.

At the next level of certification, Class 2 operator exam applicants are required to obtain one year of approved operating experience that must be acquired at a wastewater treatment plant that contains a point score of 31 or greater. Applicants are also required to take two training courses, the Basic Operations Course approved by NYSDEC, and the Basic Laboratory Procedures course. The Basic Laboratory Procedures course consists of thirty hours, or five days, of training that includes laboratory procedures and safety. However, if applicants possess professional lab experience, they may be exempt from the course if approved from NYSDEC. Also, any candidates who wish to become certified for activated sludge at Grade level 2, must complete an NYSDEC approved "Activated Sludge Operations Course". This 24 hour, or four day, training course covers basic process overview, nitrification, problem-solving, and process control record keeping, as well as course activities at nearby wastewater treatment facilities.

When applying for a Grade 3 operator license, applicants are required to have completed all training courses that were required at Grade level 2 plus the Grade 3 Supervision and Technical Operations Course. There are two options for the Grade 3 Supervision and Technical Operations Course: an approved home-study course plus a one day Technical Operations module or a five day NYSDEC approved Supervision Course and Technical Operations module. The Home-Study Course options for Grade 3 operator applicants consist of the following: "Manage For Success" by California State University-Sacramento, "Supervisory Management in the Water/Wastewater Field" by Michigan State University, and "Basic Supervision and Basic Management" by Indiana State University. The one-day Technical Operations Module is designed to improve technical operational skills of operators and the topics include multi-media, toxics, odor control, and nutrient removal. The other option, the Grade 3 Supervision and Technical Operations course, comprises of thirty hours of training, including toxics, odor control and nutrient removal, communication and training skills, motivation skills, and basic human

relations skills. Along with meeting the training requirements, Grade 3 operator applicants are also required to meet both operating and approved operating experience criteria. There are different options depending on educational background. Applicants who possess a high school or equivalency diploma, are required to have three years of operating experience that can be acquired at any wastewater treatment plant, as well as 1½ years of approved operating experience that must be acquired at a wastewater treatment plant that contains a point score of 56 or higher. Applicants who possess an Applied Associate in Science Degree must have 1½ years of operating experience obtained at any wastewater treatment plant, as well as 1½ years of approved operating experience acquired from a wastewater treatment plant that contains a point score of 56 or greater. Finally, applicants who possess an approved AAS Degree or Bachelors Degree, only need to possess 1½ years of approved operating experience acquired at a wastewater treatment plant that contained a point score of 56 or higher.

Applicants who seek to obtain a Class 4 license are required to take a Class 4 Management Training course in addition to all training courses required for operator Classes 3 and 2. These courses include Basic Operations, Laboratory Proficiency, and the Supervision and Technical Operations course. The Grade 4 Management Training course is provided by multiple sources and is approved by the NYSDEC. The Grade 4 Management course consists of eighteen hours of training and covers an array of both lecture and classroom interactive activities. Topics include grant management skills, budgeting and financial skills, political relations, and media relation skills. Upon completion of this course, Class 4 applicants will have taken a total of four different required training courses. Class 4 applicants are also required to meet experience requirements depending on their education background. The approved operating experience for Class 4 operator applicants must be acquired at a WWTP that contains a point score of 76 or higher. Applicants who only possess a high school diploma or equivalency diploma are required to obtain six years of operating experience that can be acquired at any WWTP, as well as two years of approved operating experience. Class 4 applicants who possess an AAS must obtain three years of operating experience that can be acquired at any WWTP, as well as two years of approved operating experience. Applicants who possess an approved AAS Degree only need to obtain 1½ years of operating experience that can be acquired at any WWTP, as well as two years of approved operating experience. Lastly, if an applicant possesses a Bachelors Degree, they

need only obtain two years of approved operating experience. Appendix C contains tables showing New York's wastewater operator training requirements.

8.4 Texas Wastewater Operator Training

In Texas, wastewater operators who seek to obtain an operator license must meet a set of education, experience, and training requirements. From highest to lowest, the operator levels are: Class D, C, B, and A. Applicants who wish to obtain a Class D license must either have a GED or high school education, and do not require any operations experience. Class D applicants must also have twenty hours of initial training credit. Class C license applicants require either a high school education or GED, two years of operating experience, and sixty hours of initial training credit. Class B wastewater operators can obtain a license via two different paths, depending on education level. If the applicant only has a high school education or GED, he or she must obtain five years of experience and 100 hours of initial training credit. However, if the applicant has a Bachelor's Degree in chemistry, biology, engineering, microbiology, bacteriology, or any similar approved discipline, only 2½ years of experience are required along with the 100 hours of initial training credit. For the highest level of certification, Class A, experience and training requirements also depend of education level. If the applicants only possess a high school education of GED, they will be required to have eight years of experience as well as 160 hours of initial training credits. Applicants, who possess a Bachelors Degree in chemistry, biology, engineering, microbiology, bacteriology, or any similar approved discipline, need only five years of experience and 160 hours of initial training credits. Applicants, who possess a Masters Degree with a major in chemistry, biology, engineering, microbiology, bacteriology, or any other similar approved discipline, need only have four years of experience and 160 hours of initial training credits. For Classes C, B, and A, 40 hours of additional wastewater training or 32 semester hours of college may be substituted for one year of experience.

There are a total of ten courses that constitute the initial training requirements for operator certification in Texas. The ten courses consist of the following: Advanced Management, Basic Wastewater Operations, Wastewater Treatment, Wastewater Collection, Wastewater Laboratory, Water Utility Safety, Water Utility Calculations, Water Utility Management, Intermediate Wastewater Laboratory, and Wastewater Technology. All of the

courses are twenty hours long except for Intermediate Wastewater which is 32 hours long, and Wastewater Technology, which is 40 hours long. For applicants who wish to obtain their Class D license, the Basic Wastewater Operations course is required and must be taken to fulfill the twenty hours of necessary initial training. Class C applicants are required to obtain sixty hours of initial training and must take two required courses, Basic Wastewater Operations and Wastewater Treatment, as well as at least one elective course. Possible electives for a Class C license include Wastewater Collection, Wastewater Laboratory, Water Utility Safety, or Water Utility Calculations to complete the sixty hours of initial training. Class B level applicants are required to obtain 100 hours of initial training and must take four classes, as well as at least one elective. The four classes include Wastewater Treatment, Wastewater Collection, Wastewater Laboratory, and Water Utility Safety. The three elective courses available for Class B applicants include Water Utility Calculations, Water Utility Management, and Intermediate Wastewater Laboratory. Class A applicants must obtain 160 hours of training and are required to take five classes, as well as at least one elective. The five required courses include Wastewater Treatment, Wastewater Collection, Wastewater Laboratory, Wastewater Utility Safety, and Water Utility Management. These five courses combine for a total of 100 hours of required training. The remaining 60 hours of training must include at least one of the following elective courses: Advanced Management, Water Utility Calculations, Intermediate Wastewater Laboratory, or Wastewater Technology. Among the listed electives, there are alternative providers and training courses that can be taken to fulfill the remaining forty hours of required training and can be found on the following website: http://www.tceq.texas.gov/licensing/training/water-operator-courses-and-providers. Appendix D gives tables detailing Texas's wastewater operator training requirements.

8.5 California Wastewater Operator Training

In California, there are five levels of operator certification that can be achieved. The wastewater operator levels from lowest to highest consist of the following: Grades 1, 2, 3, 4, and 5. Operators are required to meet both the experience and education requirements for each grade level prior to certification. Education points can be obtained via completion of an accredited college or university course curriculum that is directly related to wastewater treatment. Education points can also be obtained through completion of classroom training and CEU courses directly related to wastewater treatment. It is also important to note that education points

can also be acquired through the completion of classroom courses that are indirectly related to wastewater treatment. However, doing so would result in operators receiving only half the amount of education points that directly related wastewater treatment courses would provide.

Education points are only mandatory when obtaining a Grade 1 license. All remaining Grade levels higher than 1, can be achieved without obtaining any additional education points. At the lowest level of certification, Grade 1 applicants are required to obtain six education points, as well as one year of experience performing operator duties while holding an Operator-in-Training Certificate. Operators-in-Training are employees who gain operating experience under the direct supervision of a certified operator, in order to obtain qualification for an operator certificate.

At the next level of certification, Grade 2, the requirements depend on education level. With a high school diploma or equivalent, six education points and two years of operator experience while holding an operator certificate are required. The time-in-grade path, requires Grade 2 operator applicants to have 1 ½ years working in operations while in possession of a Grade 1 certificate and no education point requirements. Grade 3 exam applicants can qualify in several ways. Options include: sixty college semester units that include fifteen units of basic science or an Associates Degree plus two years of operator experience while holding a certificate; high school diploma or equivalent plus sixteen education points plus four years of operator experience while holding a certificate; or three years time-in-grade (holding a Grade 2 certificate).

Grade 4 wastewater operator applicants have four different ways to qualify. Applicants possessing a Bachelors Degree in a major related to wastewater treatment that included thirty semester units of basic science courses, also need two years of operator experience while holding a certificate. Applicants with either an Associate's Degree or sixty college semester units including fifteen semester units of basic science courses, need four years of operator experience while holding a certificate. Applicants with only a high school diploma or equivalent, need 32 education points and six years of operator experience. Applicants with four years of experience while holding a Grade 3 certificate do not need any educational credits to qualify.

Grade 5 operator applicants have five ways to qualify. If an applicant possesses a valid license as a civil or chemical engineer that has been issued by the California Board of Registration for Professional Engineers and Land Surveyors, four years of operator experience

while holding a certificate are required. Applicants with a Bachelor's Degree in a major related to wastewater treatment that includes thirty semester units of basic science courses, must have five years of operator experience while holding a certificate. Applicants with an Associates Degree must have six years of operating experience while holding a certificate. Applicants with a high school diploma or equivalent, need 48 education points and ten years of operator experience while holding a certificate. Time-in-grade applicants need six years while in possession of a Grade 4 certificate and nothing else.

Another type of training that is offered in California is the Wastewater Treatment Plant Operation Specialist Certificate Program. The program is provided by Sacramento State University and allows students to create a training regimen that is flexible to their schedules. This wastewater training program offers classes as correspondence courses; which use training manuals that have been published by Sacramento State Office of Water Programs. There are three different classes that students may enroll in: Operation of Wastewater Treatment Plants I, Operation of Wastewater Treatment Plants II, and Advanced Wastewater Treatment. A total of eighteen units of academic credit are earned upon completion of the three courses (6 credits each) along with a Wastewater Treatment Plant Operation Specialist Certificate. The courses provided in the Specialist Certificate training program satisfy both initial training and continuing education requirements for wastewater treatment licensing. Appendix E gives more information pertaining to California's wastewater training.

8.6 Five State Comparative Overview

All of the wastewater certification programs of New Jersey, Georgia, New York, Texas, and California require training of some degree prior to operator certification. The State of New Jersey requires pre-certification training for all operator levels; ranging from 135 hours to 225 hours. With the number of hours based on the level of operator certification as well educational background. The courses consist of just two major sections, Introductory Courses and Advanced Courses. Out of the five states researched, New Jersey required the highest total of training hours prior to certification. The State of Georgia also requires pre-certification training for all operator levels. Although it is not necessary for an operator to enroll in the curriculum provided by Georgia, general courses/topics have been specified within the training requirements that must be completed. Similar to New Jersey, the specified courses in Georgia have been

categorized as basic operator courses and advanced operator courses. The amount of training hours required depends on certificate level and education background and ranges from 48 to 70 hours.

In New York, the training requirements for wastewater operators are structured to follow a progressive outline. Through such a configuration, operators are required to complete training requirements at the level of which they seek to become certified, along with any other required training at lower grade levels. At the lowest operator grade level, operators are required to complete one approved training course. As the level of certification increases, so does the amount of training courses required. At the highest level of certification, operators are required to have completed four approved training courses. Operators are also given the option to obtain an operator's license required to work with activated sludge as well. Including activated sludge license specifications, the required amount of training for operators' ranges from a minimum of 60 hours to a maximum of 170 hours. For the State of Texas, operators are required to take specific courses as well as a choice of electives. On the lowest classification, Texas operators are required to take one 20 hour course. For the highest level of certification in the State of Texas, operators are required to take five specified courses as well as at least one elective course from a set criterion. The total amount of training hours that must be acquired for the highest level of wastewater operator certification in the state of Texas is 160 hours

In the State of California, operators are required to obtain education points, which can be obtained through classroom training or CEU courses. The University of California, Sacramento, is one of the key providers of wastewater training programs nationwide and has a variety of different courses operators can enroll in. The amount of education points that wastewater operators are required to obtain prior to certification, range from 6 to 48 points. However, the highest level of operator certification can be obtained with as little as six education points in the operator chooses the time-in-track option. California has five levels of operator certification, as well as a Wastewater Treatment Plant Operation Specialist Certificate Program. One of the most beneficial aspects of integrating such a program within operator training is the flexibility that it provides in regards to the participants work or academic schedules. Through such training, participants are able to obtain education points as well as academic credits that can be utilized to fulfill pre-certification requirements and possible advanced degree requirements.

One interesting observation amongst the five states was the relationship between education backgrounds and training requirements. The State of California's wastewater operator program is highly dependent on the level of background education applicants possess. Aside from Grade 1, applicants who possess a degree higher than that of a high school diploma or equivalent are not required to obtain any education points prior to certification. In comparison, the states of Georgia, New York, and Texas, all require operators to complete a set of training requirements, and the amount of required training for each grade level is the same for all educational backgrounds. The State of New Jersey also requires operators to complete a set training curriculum prior to certification. However, applicants can be exempt from the mandatory Introductory Course if they possess a degree higher than that of a high school diploma.

Another interesting observation was the commonality of required course subject material. Except for California, the four remaining states contained similar required training course subjects. All states require basic science subjects as well as treatment process operation and maintenance and various management subjects. In general, all four states required both introductory courses as well as advanced courses prior to certification. California, on the other hand, did not require specific courses or curriculum to be taken and education points could be obtained through both directly and indirectly related wastewater treatment courses. Variations amongst the curriculum of all five programs were observed and expected; due to the differences in wastewater treatment facilities throughout each of the five states.

9.0 Development of the Hawaii Boot Camp Program

Three Boot Camp Programs were created for the City and County of Honolulu (CCH), to provide a means of standardizing the wastewater operator profession in Hawaii. In the State of Hawaii, there are no set of training curriculums that wastewater operators are required to follow for certification. It was reasoned, that this is part of the reason for low passing rates on wastewater operator certification exams. Therefore, the creation of a training program was sought by CCH, to provide aid in addressing the issues of operator training in Hawaii.

The three Boot Camp Programs that have been created consist of 30, 60, and 90 day curriculums. Each training program is intended to provide entry level operators with the knowledge needed to rapidly obtain a high level of basic proficiency in wastewater operations,

allow them to pass the Grade 1 certification exam, and then efficiently progress on to higher levels of certification. The courses for the Boot Camp Programs were selected based upon the Association of Boards of Certification's (ABC's) Need-To-Know Criteria. The ABC Need-To-Know Criteria consists of numerous wastewater operator guidelines and specifications that were determined through the analysis of task surveys, as well as operator performance ratings taken in 2010. Through such analysis, a set of wastewater treatment operator core competencies were identified and comprised of the following job duties: operate equipment, laboratory analysis, monitor, evaluate, & adjust treatment processes, evaluate & maintain equipment, evaluate physical characteristics of wastestream, and perform security, safety, & administrative procedures. ABC specifies the percentages of the questions from each of these topics on each level of certification exam.

Utilizing the ABC Need-To-Know Criteria as a basis, courses were selected to ensure that the six major categories required for certification were included and included in the correct proportions. The Special Wastewater Plant Operations Certificate outline of courses for Hawaii, served as a starting point during the selection process. The Hawaii Special Wastewater Plant Operations Certificate is an optional, extra certificate of achievement that can be obtained by operators if they complete additional training courses. During the next process of selection, additional courses were added or removed in accordance to relevance. These courses consist of existing wastewater courses that are provided by the SWOTC, as well as one new course that will be created for the Boot Camp Programs. Each classroom training course was then proposed to encompass four hours of morning classroom training. In addition, hands-on training was also added to the curriculum to provide operators with another perspective on learning; encompassing visual and physical applications and analysis to enhance material retention. Each hands-on training session will consist of three hours of both instructional training and hands-on experience from a qualified supervisor.

9.1 Hawaii 30 Day Boot Camp Program

The 30 Day Boot Camp will encompass eighty hours of classroom training and sixty hours of hands-on training, over the course of four weeks. Classroom courses will include nine different major topics: Introduction to Wastewater Treatment, Safety, Clean Water Act/Regulations/Permits, Math, Physics, Chemistry, Microbiology, Treatment Methods, and Direct Responsible Charge (DRC). Each section of classroom training will be conducted in the

morning, with each class consisting of four hours of instruction per day. The first training classroom session will be based on SWOTC Course #101 Basic Course for Wastewater Treatment Plant Operators. Prior to any training, it is essential to ensure that the students obtain a general understanding of the material and duties of their occupation. This course will consist of a brief overview of three main topics that include the characteristics of sewage, natural biological treatment processes, and waste treatment methods. Aerobic and anaerobic decomposition, as well as introductory concepts of treatment at a wastewater plant are some of the main discussions that will be incorporated into the 101 Basic Course. The next major subject of the 30 Day Boot, comprises of a safety section that consists of four different classes; totaling sixteen hours of classroom time. The four safety courses will include materials from the following SWOTC courses: 103 Plant Safety, 106 Hazard Communication Program, 114 Permit-Confined Space Entry, and 118 First Aid and CPR. The first course, 103 Plant Safety, will comprise of a brief outline of fire safety, hazardous substances, personal safety, and respiratory protection that are essential for enhancing plant worker safety. Course 106 Hazard Communication Program, will provide training and knowledge on hazardous chemicals that are found within wastewater treatment plants, including obtaining and identifying material safety data sheets and lists of hazardous chemicals, the physical and health hazards of chemicals, explanations of hazardous chemical labeling, and methods of detecting the presence or release of hazardous chemicals. The safety course, 114 Permit-Confined Space Entry will cover safety requirements pertaining to entering and working in confined spaces. The topics of discussion include permit system requirements of entry supervisors, mandatory training, hazards, and rescue services. The last safety course, 118 First Aid and CPR will consist of training provided by the American Red Cross.

The third major section of training, The Clean Water Act, Regulations, and Permits section will be a combination of two courses in one. Courses 108 National Pollution Discharge Elimination Systems (NPDES), Underground Injection Control (UIC) Permits, and CWA Regulations and 112 State Regulations Affecting WTW's Workshop will be merged into one course of training. The first half of the course will contain a brief overview of NPDES/UIC permit requirements, as well as other wastewater operation regulatory requirements. The Federal Clean Water Act (CWA) as well as State of Hawaii Revised Statues and Administrative Rules applicable to wastewater operations will also be covered. During the second half of the course,

students will obtain an overview of additional regulations pertaining to operation and maintenance inspections, spill protocols, enforcement policies, sewage sludge, effluent reuse, and wastewater operator certification.

The fourth major section of training, Math, consists of materials from three courses: 105 Wastewater Mathematics, 216 Basic Wastewater Operator Math I, and 217 Basic Wastewater Operator Math II. The first course, 105 Wastewater Mathematics, is intended to serve as a refresher course of various basic mathematics problems that wastewater treatment operators may encounter on a daily basis. The second course, 216 Basic Wastewater Operator Math I, is intended to provide both elementary and basic math training that Grade 1 operators would be required to understand. Some of the topics of discussion include fractions, scientific notation, whole numbers, decimals, cancellation of units, and chlorine dosage calculations. The last unit of the Math training, 217 Basic Wastewater Operator Math II, will aid in providing students with the necessary mathematical wastewater treatment knowledge necessary for certification exams. The math topics that will be covered include flow and detention time calculations, chlorination, chemical feed rates, areas and volumes, removal rates and efficiencies, chemical reactions and solutions, statistical concepts, and pH calculations.

The fifth major section of training, Physics, will include two days of material from the 215 Plant Sciences course. During this time, four major topics of discussion will be covered and include science fundamentals, properties of matter, heat, and process dynamics. The first section, science fundamentals, will provide an overview of basic scientific principles, such as the laws of force and motion, as well as their applications in wastewater treatment facilities. The next section of training, properties of matter, will provide students with concepts of properties of matter that are associated with gases, liquids, and solids. Day 2 of the Physics training segment will comprise of heat and process dynamic topics. During this session, principles of heat transfer, liquids, gases, and vapor systems, as well as temperature relationships and thermal energy, are some of the topics that will be discussed.

The sixth major section of training, Chemistry, will consist of a new chemistry course: 117 Wastewater Chemistry. During this course, basic concepts of chemistry, such as atoms, molecules, states of matter, chemical bonding, chemical feed applications, and chemical analyses, will be covered to provide a brief chemistry overview. The next section of training, Microbiology, will also only consist of one training course: 310 Activated Sludge Microbiology.

This course will cover the basic functions of various microbes as well as discuss the relationship that exists between relative predominance of organisms and conditions of activated sludge.

The eighth major training section, Treatment Methods, will consist of material from five different topic courses: 201 Activated Sludge Control, 205 Equipment Operations – Operator Techniques & Practices, Lubrication, Heat Exchanges & Valve Operations, 208 Pump Controls, Types, Operation, and Maintenance, 210 Sludge Handling, Process, Treatment and Disposal, and 214 Waste Treatment Processes, Community Wastewater System, Pretreatment and Clarification. The first course, 201 Activated Sludge Control, covers the process control associated with activated sludge systems. Such topics of discussion include maintenance of Biological Oxygen Demand (BOD), Suspended Solids (SS), and Chemical Oxygen Demand (COD). The next course, 205 Equipment Operations, will consist of basic equipment operation techniques and practices, as well as guidelines and safety protocols. Training course 208 Pump Controls, Types, Operation, and Maintenance will be the third section of training for Treatment Methods and will cover the basic components of pumps and pump processes. The next course, 210 Sludge Handling, Process, Treatment, and Disposal, will serve to educate students about the processing of wastewater sludge. Topics of training will include the processing of sludge, creation of sludge, aerobic and anaerobic digestion, the thickening of sludge, and operational & control procedures involved in sludge dewatering. The last course, 214 Waste Treatment Processes, Community Wastewater System, Pretreatment, and Clarification, will incorporate four units of training. These four units include a review of the composition of normal domestic wastewater, community wastewater systems, pretreatment aspects, and an overview of clarification processes and purposes. The final classroom course will consist of a single four hour session on Direct Responsible Charge (DRC). During this course, plant responsibilities of a wastewater operator will be covered. The total amount of classroom training to be covered during the 30 Day Boot Camp is eighty hours. Examinations are proposed for each major section of the course and passing scores of 70% will be required. If a student does not pass, it may be possible to study at home and retake the exam. It proposed that participating operators receive CEU credits for all course segments for which they receive a passing final score (70%). The number of CEUs would be one for every 8 hours of course material passed.

In addition to classroom training, operators will undergo hands-on sessions during the afternoon. The afternoon hands-on training will include four different topics: preliminary

treatment, primary treatment, secondary treatment, and solids handling. The process of operation, start up, shut down, maintenance, and troubleshooting will be incorporated into the training of each treatment process. Each hands-on session will be conducted over the duration of three hours per day, in the afternoons. During training sessions, operators will be given instructional training, as well as hands-on experience, from an experienced operator/supervisor in accordance to the corresponding topic. Hands-on training should include exposure to various different wastewater treatment plants around the island of Oahu. There are nine City wastewater treatment plants located on the island of Oahu: Honouliuli, Kahuku, Kailua, Laie, Paalaa Kai, Sand Island, Wahiawa, Waianae, and Waimanalo. Wastewater treatment plant rotations will be implemented to provide a much more thorough and diverse set of operational experience. Since there are wide variations in equipment and processes at the nine City wastewater treatment plants, it is necessary to ensure that operators are exposed to all aspects of operations. One significant difference amongst the wastewater plants is the level of treatment that each provides. For example, Sand Island WWTP is an advanced primary treatment facility and includes utilization of UV disinfection. Honouliuli WWTP also provides primary treatment and only provides secondary treatment to part of the flow for reuse. Waianae WWTP, Kailua WWTP, Kahuku WWTP, Paalaa Kai WWTP, and Waimanalo WWTP, provide secondary treatment of wastewater. Secondary treatment includes activated sludge processes as well as tricklng filter solids contact and soon a membrane bioreactor at Wahiawa. Laie and Wahiawa both provide tertiary treatment. Each plant has different types of pumps, blowers, aerators, screens, disinfection, etc.

As a result of variations in treatment processes and methods, the ability of operators to work at other wastewater treatment facilities can be hindered, if they are not sufficiently exposed to all aspects of county-wide operations. Therefore, rotation amongst the City wastewater treatment plant facilities is vital for providing operator trainees with sufficient operations experience and knowledge. The schedule of hands-on training is as follows: three days of preliminary treatment, three days of primary treatment, six days of secondary treatment, and eight days of solids handling. The hands-on training will account for a total of sixty hours. In total, participants of the 30 Day Boot Camp will have completed 140 hours of training. After completion of the eighty hours of classroom training, operators will receive ten CEU's that can be used to fulfill requirements necessary for certification (only portions for which they pass the

final exam). Appendix G shows a complete outline of the 30 Day Boot Camp as well as additional information.

9.2 Hawaii 60 Day Boot Camp Program

The 60 Day Boot Camp consists of the same layout as that of the 30 Day Boot Camp schedule. However, each classroom and hands-on sessions have been doubled in duration to allow a much more comprehensive training program. Over the course of eight weeks, classroom training courses will be conducted five days a week, for a total of 160 hours of training. Afternoon sessions will consist of a total of 120 hours of hands-on training. Operators will also be able to receive twenty CEU's after completion of the classroom courses, which can be used to fulfill any CEU requirements for certification. Appendix G shows an outline of the 60 Day Boot Camp curriculum as well as additional information.

9.3 Hawaii 90 Day Boot Camp Program

The 90 Day Boot Camp will consist of a similar layout to that of the 30 and 60 Day Boot Camp Programs. Classroom training will be conducted over the course of twelve weeks, five days a week, for a total of 240 hours of classroom training. In addition to the courses listed for the 30 and 60 Day Boot Camps, two major additional sections of classroom training have been added to create the 90 Day Boot Camp. The two major sections of training include Electricity and Collection Systems. The Electricity section of training will include major portions of the 102 Basic Electricity Review and Reading Electrical Diagrams course over the duration of two days (eight hours). The 102 Basic Electricity Review and Reading Electrical Diagrams Course will provide a review of fundamental electrical concepts and cover the following topics: basic electrical quantities, parallel and series circuits, the nature of electricity, Ohm's Law, inductance, electromagnetism, and capacitance. In addition, students will also learn how to read four types of electrical diagrams: block diagrams, schematics, single line diagrams, and wiring diagrams. The other additional major section of training, Collection Systems, will also incorporate one course over the duration of two days (eight hours). The training curriculum that will be utilized is the 104 Wastewater Collection Systems Basic Course. This course will provide students with an introduction to the maintenance and operation of wastewater collection systems. Some of the topics of discussion for this course include sewer types, inflow, infiltration, exfiltration, and three types of wastewater collection systems. Another change to the 90 Day Boot Program is the

addition of major portions of six additional courses to the Treatment Methods Section of training. These six additional courses include 206 Pressure Measurement and Fluid Flow Measurement, 211 Trouble Shooting Pumps, 220 Odor Control System, 250 Mechanical Maintenance I: Air Compressors and Blowers, 251 Mechanical Maintenance II: Bearings, Lubrication, Packing, and Seals, and 253 Mechanical Maintenance IV: Valves. The 206 Pressure Measurement and Fluid Flow Measurement course will be covered over the duration of two days (eight hours). This course will provide an overview of the basic concepts of pressure, knowledge of devices & instruments used to measure pressure changes, fundamental information on differential pressure, and common fluid flow meters. The next course, 211 Troubleshooting Pumps, will be taught over the duration of three days (twelve hours). The 211 Troubleshooting Pumps course will cover the basics of normal equipment operations and backgrounds. Students will also learn how to how to analyze, investigate, repair pumping problems, and implement preventative measures. The 220 Odor Control course, will provide students with three days (eight hours) of training pertaining to odor control, safety & health issues, source control & containment, public relations, treatment technologies, and case histories. The next three courses that have been added to the 90 Day Boot Camp, are part of the 250 series of training curriculum and include: 250 Mechanical Maintenance I, 251 Mechanical Maintenance II, and 253 Mechanical Maintenance IV. Each course will consist of two days (eight hours) of classroom training for a total of six days. The three courses will cover typical maintenance operations for air compressors, blowers, bearings, lubrication, packing, seals, and valves. In total, the 90 Day Boot Camp will provide operators with 240 hours of classroom training. Upon completion of these courses, operators will also be able to receive thirty CEU's that can be applied towards certification requirements.

The afternoon hands-on training will also consist of the same layout as that of the 30 and 60 Day Boot Camp outline, with the addition of extended hands-on sessions. There will be a total of 180 hours of hands-on training over the course of twelve weeks. In total, the 90 Day Boot Camp Program will consist of 420 hours of training. Appendix G shows an outline of the 90 Day Boot Camp as well as additional information.

9.4 Hawaii Boot Camp Program Analysis

The main objective of the 30, 60, and 90 Day Boot Camps is to provide an effective method of training for entry level operators, to aid in their progression to further levels of certification. Through such programs of training, the rate at which operators obtain knowledge and experience can be increased greatly. In addition, operators are also able to obtain CEU credits that can be applied towards meeting pre-certification requirements for licensing as well; thus enabling operators to attain certification much more efficiently. The main differences between each of the Boot Camps are the durations and rates at which training contents will be covered. Each training camp increases by 140 hours of total training from the previous program. What is most significant about each of the Boot Camp curriculums however, is the emphasis in which is placed on wastewater treatment methods.

According to ABC's Need-To-Know Criteria, approximately 77% to 78% of the content on Class 1 to Class 4 certification exams encompasses equipment and treatment process related material. This is an important observation because it conveys the importance of understanding such material prior to taking a certification exam. Both the 30 and 60 Day Boot Camps contain training material related to equipment and treatment processes, which encompass over 57% of the program curriculum. The 90 Day Boot Camp equipment and treatment process related material constitute over 70% of the total training curriculum. This is important to note because it provides support that the training programs are strongly emphasizing training topics that are prevalent throughout the certification exams. Topics from the three other categories of ABC's certification exam specifications, Evaluate Physical Characteristics of Wastestream, Perform Security, Safety, and Administrative Procedures, and Laboratory Analysis, are also encompassed throughout the remainder of the Boot Camp curriculum.

10.0 Hawaii Boot Camp Program Implementation

In essence, there are two basic options for implementation of the 30, 60, or 90 Day Boot Camp Programs for the City and County of Honolulu. The first option is to require all operators to complete one of the Boot Camp Program curriculums; including current working operators of all grade levels. A variation would be to require all operators without a Grade 4 license (or those without Grade 3 or 4 license) to participate. The second basic option would be to enforce such training requirements only for new entry level operators. The latter seems much more plausible

due to the constraints and scheduling conflicts that may arise for current working operators. The three Boot Camp Programs have been created as mutually exclusive options for training. Selection of which Boot Camp Training Program to implement will depend primarily on availability of funding and the needs, objectives and goals of CCH or any other county that chooses to do so. Given adequate funding, the 90-Day boot camp would be recommended as the option to best prepare the operators. Perhaps more than one Boot Camp program could be offered annually starting at different times and they could possibly be of different durations (e.g. a Fall 90-Day Boot camp, a Spring 60-Day Boot Camp, and Summer 30-Day Boot Camp). Boot camps would need to be for cohorts (groups) of operators that start and finish at the same time. It is not recommended to set different requirements for Boot Camp Training for new operators with different educational backgrounds. By requiring all entering operators, regardless of their educational background, to complete a training program, standardization can be accomplished among wastewater operators.

Another option could also be available for current wastewater operators who are struggling to pass their certification exams beyond entry level; Grades 2, 3, and 4. One way to implement the training program for these operators would be to provide them with the option to partake in major course subjects in which they are struggling with on their certification exams. Since the training programs are created to address the ABC Need-To-Know Criteria, operators could possibly choose courses from the 30 Day Boot Camp that they feel, would aid in improving their certification scores.

11.0 Hawaii Boot Camp Comparative Overview

According to the five states that were researched, four out of five require wastewater operators to complete a specified curriculum of training courses prior to certification. The one state that does not have a specific set of required courses was California. However, California does require a minimum amount of education points to be obtained prior to certification. The minimum amount of education points that are necessary prior to Grade 1 certification in California is six points with one year of experience. However, once past a Grade 2 level, the training education requirements for operators prior to certification are dependent on the level of education that applicants possess. If operators only possess a high school diploma or equivalent, there are set amounts of education points required. At the highest grade level, operators in

California are required to obtain 48 education points and ten years of experience while holding an operator certificate. Hawaii's current wastewater certification program also incorporates the same type of criteria. In comparison, entry level operators for the State of Hawaii are not currently required to obtain any CEU's prior to certification for a Grade 1 license. However, operators are required to possess one year of operating experience. Similar to California, Hawaii also enables those with higher education degrees to bypass CEU requirements. In contrast, the other four states generally require many more hours of formal training for the various grades of wastewater operator certification. Hawaii needs to do a better job of training its operators and one way is to require such training through the proposed Boot Camps.

The Boot Camp Programs created for the City and County of Honolulu, present similar aspects to those of the other four researched states. The states of New Jersey, Georgia, New York, and Texas all share a general commonality amongst the courses in which they required operators to complete. These courses included both basic and advanced courses of training. The programs of these four states are similar to that of the created Boot Camp Programs in the sense that, training requirements are specified in regards to the training content. The state that was most similar to that of the proposed training program for Hawaii was New Jersey. What is beneficial about New Jersey's wastewater operator training program is that it provides an outline of all the required course subjects that are to be covered during training. Similarly, the proposed Hawaii Boot Camp Programs also contain specified courses that operators must take prior to certification.

Two of the largest differences between the proposed training program for Hawaii and that of the other five states are the durations of which training will be conducted, as well as the incorporation of hands-on training sessions. Respectively, the 30, 60, and 90 Day Boot Camp Programs equate to 80, 160, and 240 hours of classroom training. By comparison, the state with the largest required amount of training course hours was New Jersey, with a total of 225 hours. Such requirements in the State of New Jersey, however, pertain to the total amount of required training hours necessary to obtain their highest level of certification. The state with the second highest amount of required training was New York, with 170 total hours for their highest level of operator certification. The state that contained training hour requirements closest to the Hawaii Boot Camp Programs, in regards to entry level operators, was New Jersey. New Jersey's Introduction to Wastewater Operator Training Course Part I and II totaled 135 hours of required

operator classroom training. This requirement falls between the 80 and 160 hours of classroom training, for the proposed 30 and 60 Day Boot Camp Programs in Hawaii. The state that required the least amount of training was Georgia, in which only six hours of basic training were required for entry level operators.

As stated earlier, the recommended Boot Camp is the 90-Day version because it packs the most punch in the sense that it covers the most material, in the most depth, and still completes the whole thing in 3 months. It seems clear that highly qualified and motivated operators would emerge from the 90-Day Boot Camp and it further seems like a fairly small investment for an employee that the CCH hopes to have for 40 years.

12.0 The Hawaii Wastewater Operator Career Brochure

In order to enhance the professional quality of wastewater operators, improvements must also be made pertaining to recruitment. One way this can be accomplished is through public education about wastewater operator professions and job opportunities. A draft brochure has been created to provide the public with such information. The Hawaii Wastewater Operator Career Brochure contains basic information, pertaining to wastewater treatment plant operators as a whole. Along with basic information required for certification licenses, the brochure also includes the salaries of operators from Grades 1 to 4. The operator career brochure is intended to provide quick, accessible information about wastewater operators as well as serve as a method of recruitment. Some of the possible outlets for distribution of this brochure include public schools and colleges. Coupled with the new, created Boot Camp Programs, distribution of brochures could enhance the possibility of recruiting younger operators to a career in wastewater and thereby build a stable, professional workforce for the long-term and forestall expected operator shortages in the future.

13.0 Conclusion

Wastewater operators are incredibly important for successful and economical treatment, disposal, and recycling of wastewater for protection of public health and the environment. These operators have to be highly skilled and understand myriad information both basic and applied related to operation, maintenance, and troubleshooting of numerous different processes and equipment. Such skills are not innate and must be learned efficiently, effectively, correctly, and

relatively quickly through a combination of formal classroom-type training and hands-on type on-the-job type training. Three different Boot Camp Programs have been created for the City and County of Honolulu, to provide a means of implementing a new, diverse, and efficient method of operator training. The Boot Camp Programs have been created and outlined in accordance to ABC's Need-To-Know Criteria for wastewater operator certification exams. By utilizing ABC's criteria, the Boot Camp Programs seek to provide operators with optimal training curriculum, necessary for passing their certification exams. Both classroom courses, as well as hands-on training, have been integrated into all three programs to provide entry level operators with the necessary knowledge needed, to efficiently pass their Grade 1 exam and then progress to further levels of certification.

Each of the Boot Camp Programs that were created, vary in duration by a difference of 140 total hours of training. However, all three Boot Camps provide exceptional training program options for operators regardless of their duration. The Boot Camp program curriculum focuses on covering the major core subjects found on certification exams; equipment and treatment processes. Both the 30 and 60 Day Boot Camp curriculums comprise of 57% material related to equipment and treatment processes. The 90 Day Boot Camp curriculum also encompasses a large majority of focus pertaining to equipment and treatment process as well; with approximately 70% of the material related to such areas. According to ABC's Need-To-Know Criteria, approximately 77%-78% of the certification exams consist of equipment and treatment process related materials. Since the required passing percentage for a certification exam is 70%, operators in Hawaii can significantly improve their probability of passing certification exams simply from obtaining training in those related areas alone. In addition, the Boot Camp Programs also serve as an efficient method of enhancing wastewater operators in Hawaii. By standardizing the professional outcomes of wastewater operators, the profession as a whole, can be elevated in the State of Hawaii. In turn, recruitment of younger operators can also result as a byproduct; thus providing stability to the anticipated operator shortage in the near future. However, more studies must be conducted pertaining to the ways in which City officials would like to utilize the Boot Camp Programs. Additional studies must also be conducted in regards to locations, instructors, and financial costs associated with implementation of the Boot Camp Programs as well. Further research must also be conducted in regards to the City's wastewater treatment plant processes and rotation schedules of trainees during hands-on training sessions.

At this point in time, only the City and County of Honolulu is likely capable of providing the resources necessary to conduct such training programs, and if feasible, the 90-Boot Camp is proposed as the optimal solution for moving forward. The Boot Camp Programs do, however, serve as a basis for future development of wastewater operator training programs throughout the entire state to enhance the wastewater operator profession in Hawaii as a whole.

Appendices

Appendix A: New Jersey Wastewater Operator Training Curriculum and Certification Requirements

New Jersey Wastewater Operator Required Training Curriculum

Introduction to Wastewater Operator Training Course Part I	
Course Subject	**Duration (hrs)**
Mathematics	36
Physics	26
Chemistry	11
Microbiology	11
Miscellaneous	6
Test	-
Total	**90**

Introduction to Wastewater Operator Training Course Part II	
Course Subject	**Duration (hrs)**
Administrative	4
Wastewater Sources and characteristics	2
Treatment Methods	25
Disinfection	2
Wastwater Analysis and Interpretation	3
Collection System	6
Test	-
Field Trip	3
Total	**45**

New Jersey Wastewater Operator Required Training Curriculum Cont'd

Advanced Wastewater Operations Course	
Course Subject	**Duration (hrs)**
Administrative	15
Wastewater Sources & Characteristics Review	1
Treatment Methods	27
Sludge Digestion and Solids Handling	22
Advanced Treatment	11
Disinfection	3
Field Trip	3
Laboratory Analysis and Operation Control	8
Test	-
Total	**90**

New Jersey Wastewater Operator Certification Requirements

Wastewater Class Level	Education Requirement Options	Training Requirements	Operating Experience Requirements (Years)	Direct Responsible Charge Experience (Years)	Total Operating Experience (Years)
1	High School Diploma or Equivalency Certificate	NJPED Approved Introductory Course	1	0	1
	*Associate's Degree	-	1	0	1
	**Bachelor's Degree	-	1	0	1
2	High School Diploma or Equivalency Certificate	NJPED Approved Introductory Course + Advanced Course	3	0	3
	*Associate's Degree	Advanced Course	2	0	2
	**Bachelor's Degree	Advanced Course	1.5	0	1.5
3	High School Diploma or Equivalency Certificate	NJPED Approved Introductory Course + Advanced Course	3	3	6
	*Associate's Degree	Advanced Course	2	2	4
	**Bachelor's Degree	Advanced Course	1.5	1.5	3
4	High School Diploma or Equivalency Certificate	NJPED Approved Introductory Course + Advanced Course	6	4	10
	*Associates Degree	Advanced Course	4	3	7
	**Bachelor's Degree	Advanced Course	3	2	5

* Applicants will meet the associate's degree education requirements if they successfully completed two years of formal education and obtained an engineering or related science degree, post-secondary vocational program, or bachelor's degree in a field that is not met within the Bachelor's Degree category.
**Applicants will meet the Bachelor's Degree education requirements if they have obtained a degree in engineering or related science.

Appendix B: Georgia Wastewater Operator Training Curriculum and Certification Requirements

Georgia Wastewater Operator Training Curriculum Options

Class II Wastewater Treatment	Duration	Class III Wastewater Treatment	Duration	Class IV Small Wastewater Treatment	Duration
Suspended Media Treatment	24 hours	Wastewater Mathematics	40 hours	Wastewater Characteristics	6 hours
Mathematical Calculations		Activated Sludge Process		Pond Life (Bacteria/Algae)	
Secondary Treatment		Natural Treatment Systems		Pond Sampling	
Sludge Treatment		Disinfection		Pond Operation & Maintenance	
Disinfection		Solids Handling		Troubleshooting	

Industrial Wastewater Treatment	Duration	Wastewater Math Part I	Duration	Wastewater Math Part II	Duration
Wastewater Mathematics	27 hours	Solve for Area	6 hours	Activated Sludge Math	12 hours
Pretreatment Standards		Solve for Volume		Trickling Filter Math	
Chemical Treatment		Basic Conversions		Digestion & Dewatering Math	
Metals Removal		Interpretation of written problems		Collection System Math	
Safety		Process control application		Pumping Math	

Georgia Wastewater Operator Training Curriculum Options Cont'd

Activated Sludge Part I	Duration	Activated Sludge Part II	Duration	Collection Systems Operation & Maintenance	Duration
Overview of Suspended Media Treatment	12hours	Short Term Process Control	12 hours	Collection System Math	27 hours
Modifications of Activated Sludge Processes		Oxygen Uptake Rate		Collection System Components	
Unit Processes & Their Functions		Sludge Quality		System Maintenance	
Long Term Process Control		Practical Application of Data		Safety	
Math Application System Operation				Pumps & Pumping	

1-Day Course	Duration
Confined Space Entry	6 hours
Wastewater Collection	
Systems Review	
Sludge Handling	
Process Control Review	
Pumping Systems	

Georgia Wastewater Operator Certification Requirements

Biological Wastewater Treatment System Operator Class	Education Requirement Options	Training Requirements	Operating Experience Requirements (Months)
4	High School Diploma or GED Certificate	6 hours of basic water operator course work	1
4	*Accredited Associates Degree	6 hours of basic water operator course work	1
4	**Accredited Bachelor of Science	6 hours of basic water operator course work	1
3	High School Diploma or GED Certificate	40 hours of basic water operator course work	3
3	*Accredited Associates Degree	40 hours of basic water operator course work	3
3	**Accredited Bachelor of Science	40 hours of basic water operator course work	3
2	High School Diploma or GED Certificate	48 hours of advanced water operator course work	24
2	*Accredited Associates Degree	48 hours of advanced water operator course work	18
2	**Accredited Bachelor of Science	48 hours of advanced water operator course work	12
1	High School Diploma or GED Certificate	No Additional Training	36
1	*Accredited Associates Degree	No Additional Training	30
1	**Accredited Bachelor of Science	No Additional Training	24

*Associates Degree must be in Biology, Chemistry, Engineering, or an Equivalent Degree
** Bachelor of Science Degree must be in Biology, Chemistry, Engineering, or an equivalent Degree. It can also be a current Class I certificate in another category

Appendix C: New York Wastewater Operator Training Curriculum and Certification Requirements

New York Wastewater Operator Required Training Courses

	Grade Level							
Course	**1**	**1A**	**2**	**2A**	**3**	**3A**	**4**	**4A**
Home Study Introductory Course	X	X						
Basic Operations Course	X*	X*	X	X	X	X	X	X
Activated Sludge Course		X		X		X		X
Laboratory Proficiency			X	X	X	X	X	X
Supervision & Technical Operations Course					X	X	X	X
Management							X	X
* Optional Alternate								

Course	**Duration**
Home Study Introductory Course	6 month time limit
Basic Operations Course	60 hours
Activated Sludge Course	24 hours
Laboratory Proficiency	30 hours
Supervision & Technical Operations Course	38 hours
Management	18 hours

New York Wastewater Operator Certification Requirements

Grade Level	Education Requirement Options	# of Required Training Courses	Operating Experience	Approved Operating Experience	Total Operating Experience
1	High School Diploma or Equivalency Diploma	1	-	6 Months	6 Months
	Associate in Applied Science Degree	1	-	6 Months	6 Months
	Approved Associate in Applied Science Degree	1	-	6 Months	6 Months
	Bachelor of Science	1	-	6 Months	6 Months
2	High School Diploma or Equivalency Diploma	2	-	1 Year	1 Year
	Associate in Applied Science Degree	2	-	1 Year	1 Year
	Approved Associate in Applied Science Degree	2	-	1 Year	1 Year
	Bachelor of Science	2	-	1 Year	1 Year
3	High School Diploma or Equivalency Diploma	3	3 Years	1 1/2 Years	4 1/2 Years
	Associate in Applied Science Degree	3	1 1/2 Years	1 1/2 Years	3 Years
	Approved Associate in Applied Science Degree	3	-	1 1/2 Years	1 1/2 Years
	Bachelor of Science	3	-	1 1/2 Years	1 1/2 Years
4	High School Diploma or Equivalency Diploma	4	6 Years	2 Years	8 Years
	Associate in Applied Science Degree	4	3 Years	2 Years	5 Years
	Approved Associate in Applied Science Degree	4	1 1/2 Years	2 Years	3 1/2 Years
	Bachelor of Science	4	-	2 Years	2 Years

Appendix D: Texas Wastewater Operator Training Curriculum and Certification Requirements

Texas Wastewater Operator Required Training Curriculum

	License Class Level			
Training Course	**D**	**C**	**B**	**A**
Advanced Management	N/R	N/R	N/R	E
Basic Wastewater Operations	R	R	N/R	N/R
Wastewater Treatment	N/R	R	R	R
Wastewater Collection	N/R	E	R	R
Wastewater Laboratory	N/R	E	R	R
Water Utility Safety	N/R	E	R	R
Water Utility Calculations	N/R	E	E	E
Water Utility Management	N/R	N/R	E	R
Intermediate Wastewater Laboratory	N/R	N/R	E	E
Wastewater Technology (40 hours)	N/R	N/R	N/R	E
E= Elective, R=Required, N/R=not required as part of initial training requirements				

Texas Wastewater Operator Required Training Hours

	License Class Level			
	D	**C**	**B**	**A**
Required Initial Training Hours	20	60	100	160

Texas Wastewater Operator Certification Requirements

Grade Level	Education Requirement Options	Required Initial Training Hours	Operating Experience
D	High School Diploma or GED	20	None
	Bachelor's Degree	20	-
	Master's Degree	20	-
C	High School Diploma or GED	60	2 Years
	Bachelor's Degree	60	-
	Master's Degree	60	-
B	High School Diploma or GED	100	5 Years
	Bachelor's Degree	100	2 1/2 Years
	Master's Degree	100	-
A	High School Diploma or GED	160	8 Years
	Bachelor's Degree	160	5 Years
	Master's Degree	160	4 Years

Appendix E: California Wastewater Operator Training and Certification Requirements

California Wastewater Operator Certification and Education Point Requirements

Grade Level	Education Requirement Options	Required Training	Operating Experience
1	Operator In Training Certificate	6 Education Points	1 Year while holding a OIT Certificate
2	High School Diploma or Equivalent	6 Education Points	2 Years while holding a certificate
	-	(Time-in Grade)	1 1/2 Years while holding a Grade I WWTP Operator Certificate
3	High School Diploma or Equivalency Diploma	16 Educational Points	4 Years while holding a certificate
	Associates Degree	-	2 Years while holding a certificate
	60 college semester units that include 15 semester units of basic science courses	-	2 Years while holding a certificate
	-	(Time-in Grade)	3 Years while holding a Grade II WWTP Operator Certificate
4	High School Diploma or Equivalent	32 Educational Points	6 Years while holding a certificate
	Associates Degree	-	4 Years while holding a certificate
	60 college semester units that include 15 semester units of basic science courses	-	4 Years while holding a certificate
	Bachelor's Degree	-	2 Years while holding a certificate
	-	(Time-in Grade)	4 Years while holding a Grade III WWTO Operator Certificate
5	High School Diploma or Equivalent	48 Educational Points	10 Years while holding a certificate
	Associates Degree	-	6 Years while holding a certificate
	60 college semester units that include 15 semester units of basic science courses	-	6 Years while holding a certificate
	Bachelor's Degree	-	5 Years while holding a certificate
	Valid license as a civil or chemical engineer	-	4 Years while holding a certificate
	-	(Time-in Grade)	6 Years while holding a Grade III WWTO Operator Certificate

Wastewater Operator Specialist Certificate Program - Sacramento

Course	Duration	Academic Points
Operation of Wastewater Treatment Plants I	Determined by Student	6
Operation of Wastewater Treatment Plants II	Determined by Student	6
Advanced Waste Treatment	Determined by Student	6

Appendix F: Current Hawaii Wastewater Operator Certification Requirements and Passing Rates

Current Hawaii Wastewater Operator Certification Requirements

Grade Level	Education Requirement Options	CEU Requirements	Operating Experience		Permanent License Experience
			Years	Months	
1	High School Diploma or Equivalent	None	1	0	-
2	High School Diploma or Equivalent	22	1	0	-
		21	1	1	-
		20	1	2	-
		18	1	3	-
		17	1	4	-
		16	1	5	-
		14	1	6	-
		13	1	7	-
		12	1	8	-
		10	1	9	-
		9	1	10	-
		8	1	11	-
		6	2	0	-
		None	-	-	1 1/2 Years while having a Grade 1 License
3	High School Diploma or Equivalent	32	2	0	-
		31	2	1	-
		30	2	2	-
		28	2	3	-
		27	2	4	-
		26	2	5	-
		24	2	6	-
		23	2	7	-
		22	2	8	-
		20	2	9	-
		19	2	10	-
		18	2	11	-
		16	3	0	-
		None	-	-	2 1/2 Years while having a Grade 2 License
	Associate Degree	None	2	0	-

Current Hawaii Wastewater Operator Certification Requirements Cont'd

Grade Level	Education Requirement Options	CEU Requirements	Operating Experience		Permanent License Experience
			Years	Months	
4	High School Diploma or Equivalent	48	4	0	-
		47	4	1	-
		46	4	2	-
		44	4	3	-
		43	4	4	-
		42	4	5	-
		40	4	6	-
		39	4	7	-
		38	4	8	-
		36	4	9	-
		35	4	10	-
		34	4	11	-
		None	-	-	4 Years while having a Grade 3 License
	Associate Degree	None	4	0	-
	Bachelors of Science	None	1	0	-

Note: Grades 2, 3, and 4 show the minimum and maximum CEU requirements, if the applicant only possesses a high school diploma or equivalent.
-Associates Degree qualifications includes two years at an accredited university or college with fifteen units of basic science OR fifteen units of basic science from an accredited community college.
-Bachelor's Degree must have been obtained from an accredited university or college with a major related to wastewater treatment.

State of Hawaii Wastewater Operator Certification Exam Passing Rates

Statewide Comparison of Operator Certification Exam Passing Percentages				
Date of Exam	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
August (2012)	60	50	17	29
February (2012)	35	25	56	14
August (2011)	67	67	42	50
February (2011)	55	50	32	4
August (2010)	27	24	20	0
February (2010)	79	64	31	10
August (2009)	46	24	8	5
February (2009)	52	45	57	10
August (2008)	50	41	10	6
February (2008)	50	31	22	9
August (2007)	80	40	25	25
Average	**55**	**42**	**29**	**15**

Appendix G: Proposed Hawaii Wastewater Operator Boot Camp Outlines, Curriculum, and Calendars

30 Day Boot Camp Outline

Duration - 4 Weeks (5 days/week)

- Day Time Courses (4 hour/class/day):
  - Introduction
  - 101 Basic Course For Wastewater Treatment Plant Operators (1 day)
  - Safety
    - 103 Plant Safety (1 day)
    - 106 Hazard Communication Program (1 day)
    - 114 Permit-Confined Space Entry (1 day)
    - 118 First Aid and CPR (American Red Cross provides Instructor & Materials) (1 day)
  - Clean Water Act, regulations, permits (record keeping)
    - 108/112 National Pollution Discharge Elimination Systems (NPDES), UIC Permits and CWA Regulations/State Regulations Affecting WTW's Workshop (1 day)
  - Math
    - 105 Wastewater Mathematics (1 day)
    - 216 Basic Wastewater Operator Math I (1 day)
    - 217 Basic Wastewater Operator Math II (1 day)
  - Physics
    - 215 Plant Sciences (2 days)
  - Chemistry (2 days)
    - 117 Wastewater Chemistry (New) (2 days)
  - Microbiology
    - 310 Activated Sludge Microbiology (1 day)
  - Treatment Methods
    - 201 Activated Sludge Process control (1 day)
    - 205 Equipment Operations – Operator Techniques & Practices, Lubrication, Heat Exchanges and Valve Operations (1 day)
    - 208 Pump controls, Types, Operation, and Maintenance (1 day)
    - 210 Sludge Handling, Process, treatment and Disposal (1 day)

        - 214 Waste Treatment Processes, community wastewater System, Pretreatment and Clarification (1 day)

    - DRC Course (Direct Responsible Charge) (1 day)

- Afternoon Sessions – Hands on Training (3 hours per session)
    - Includes:
        - Preliminary Treatment (3 days)
        - Primary Treatment (3 days)
        - Secondary Treatment (6 days)
        - Solids Handling (8 days)
        - Process of operations, start up, shut down, and maintenance

30 Day Boot Camp Curriculum Breakdown

30 Day Boot Camp			
Course Subject	**Duration (hrs)**	**Hands On Training**	**Duration (hrs)**
Introduction to Wastewater Treatment	4	Preliminary Treatment	9
Safety	16	Primary Treatment	9
Clean Water Act, Regulations, Permits	4	Secondary Treatment	18
Math	12	Solids Handling	24
Physics	8	-	-
Chemistry	8	-	-
Microbiology	4	-	-
Treatment Methods	20	-	-
DRC (Direct Responsible Charge)	4	-	-
Total	**80**	-	**60**
Total CEU's Received	**10**	-	**-**

30 Day Boot Camp Course List

Day Time Courses:

- 101 Basic Course For Wastewater Treatment Plant Operators
- 103 Plant Safety
- 106 Hazard Communication Program
- 114 Permit-Confined Space Entry
- 118 First Aid and CPR (American Red Cross provides Instructor & Materials)
- 108/112 National Pollution Discharge Elimination Systems (NPDES), UIC Permits and CWA Regulations/State Regulations Affecting WTW's Workshop
- 105 Wastewater Mathematics
- 216 Basic Wastewater Operator Math I
- 217 Basic Wastewater Operator Math II
- 215 Plant Sciences
- 117 Wastewater Chemistry (New)
- 310 Activated Sludge Microbiology
- 201 Activated Sludge Process control
- 205 Equipment Operations – Operator Techniques & Practices, Lubrication, Heat Exchanges and Valve Operations
- 208 Pump controls, Types, Operation, and Maintenance
- 210 Sludge Handling, Process, treatment and Disposal
- 214 Waste Treatment Processes, community wastewater System, Pretreatment and Clarification
- DRC Course (Direct Responsible Charge)

30 Day Boot Camp Calendar

January

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1 Basic Wastewater [Preliminary Treatment]	2 Basic Safety Course [Preliminary Treatment]	3 Hazard Communication Program [Preliminary Treatment]	4 Permit- Confined Space Entry [Primary Treatment]	5
6	7 First Aid and CPR [Primary Treatment]	8 CWA, Regulations, Permits [Primary Treatment]	9 Wastewater Mathematics [Secondary Treatment]	10 Math I [Secondary Treatment]	11 Math II [Secondary Treatment]	12
13	14 Physics [Secondary Treatment]	15 Physics [Secondary Treatment]	16 Wastewater Chemistry (New) [Secondary Treatment]	17 Wastewater Chemistry (New) [Solids Handling]	18 Wastewater Microbiology [Solids Handling]	19
20	21 Activated Sludge Process Control [Solids Handling]	22 Equipment Operations [Solids Handling]	23 Pump controls, types, operation, and maintenance [Solids Handling]	24 Sludge handling, process, treatment and disposal [Solids Handling]	25 Waste treatment Processes, community wastewater system, pretreatment and clarification [Solids Handling]	26
27	28 DRC [Sludge Handling]	29	30	31		

Hawaii Boot Camp Day Classes
[] = indicates afternoon hands on training

60 Day Boot Camp Outline

Duration - 8 Weeks (5 days/week)

- Day Time Courses (4 hours/class/day):
  - Introduction
    - 101 Basic Course For Wastewater Treatment Plant Operators (2 days)
  - Safety
    - 103 Plant Safety (2 days)
    - 106 Hazard Communication Program (2 days)
    - 114 Permit-Confined Space Entry (2 days)
    - 118 First Aid and CPR (American Red Cross provides Instructor & Materials) (2 days)
  - Clean Water Act, regulations, permits (record keeping)
    - 108/112 National Pollution Discharge Elimination Systems (NPDES), UIC Permits and CWA Regulations/State Regulations Affecting WTW's Workshop (2 days)
  - Math
    - 105 Wastewater Mathematics (2 days)
    - 216 Basic Wastewater Operator Math I (2 days)
    - 217 Basic Wastewater Operator Math II (2 days)
  - Physics
    - 215 Plant Sciences (4 days)
  - Chemistry
    - 117 Wastewater Chemistry (New) (4 days)
  - Microbiology
    - 310 Activated Sludge Microbiology (2 days)
  - Treatment Methods
    - 201 Activated Sludge Process control(2 days)
    - 205 Equipment Operations – Operator Techniques & Practices, Lubrication, Heat Exchanges and Valve Operations (2 days)
    - 208 Pump controls, Types, Operation, and Maintenance (2 days)
    - 210 Sludge Handling, Process, treatment and Disposal (2 days)

        - 214 Waste Treatment Processes, community wastewater System, Pretreatment and Clarification (2 days)

    - DRC Course (Direct Responsible Charge) (2 days)

- Afternoon Sessions – Hands on Training (3 hours per session)
    - Includes:
        - Preliminary Treatment (6 days)
        - Primary Treatment (6 days)
        - Secondary Treatment (12 days)
        - Solids Handling (16 days)
        - Process of operations, start up, shut down, and maintenance

60 Day Boot Camp Curriculum Breakdown

60 Day Boot Camp			
Course Subject	**Duration (hrs)**	**Hands On Training**	**Duration (hrs)**
Introduction to Wastewater Treatment	8	Preliminary Treatment	18
Safety	32	Primary Treatment	18
Clean Water Act, Regulations, Permits	8	Secondary Treatment	36
Math	24	Solids Handling	48
Physics	16	-	-
Chemistry	16	-	-
Microbiology	8	-	-
Treatment Methods	40	-	-
DRC (Direct Responsible Charge)	8	-	-
Total	**160**	-	**120**
Total CEU's Received	**20**	-	**-**

60 Day Boot Camp Courses

Day Time Courses:

- 101 Basic Course For Wastewater Treatment Plant Operators
- 103 Plant Safety
- 106 Hazard Communication Program
- 114 Permit-Confined Space Entry
- 118 First Aid and CPR (American Red Cross provides Instructor & Materials)
- 108/112 National Pollution Discharge Elimination Systems (NPDES), UIC Permits and CWA Regulations/State Regulations Affecting WTW's Workshop
- 105 Wastewater Mathematics
- 216 Basic Wastewater Operator Math I
- 217 Basic Wastewater Operator Math II
- 215 Plant Sciences
- 117 Wastewater Chemistry (New)
- 310 Activated Sludge Microbiology
- 201 Activated Sludge Process control
- 205 Equipment Operations – Operator Techniques & Practices, Lubrication, Heat Exchanges and Valve Operations
- 208 Pump controls, Types, Operation, and Maintenance
- 210 Sludge Handling, Process, treatment and Disposal
- 214 Waste Treatment Processes, community wastewater System, Pretreatment and Clarification
- DRC Course (Direct Responsible Charge)

60 Day Boot Camp Calendar

January

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1 Basic Wastewater [Preliminary Treatment]	2 Basic Wastewater [Preliminary Treatment]	3 Basic Safety Course [Preliminary Treatment]	4 Basic Safety Course {Preliminary Treatment]	5
6	7 Hazard Communication Program [Preliminary Treatment]	8 Hazard Communication Program [Preliminary Treatment]	9 Permit-Confined Space Entry [Primary Treatment]	10 Permit-Confined Space Entry [Primary Treatment]	11 First Aid and CPR [Primary Treatment]	12
13	14 First Aid and CPR [Primary Treatment]	15 CWA, Regulations, Permits [Primary Treatment]	16 CWA, Regulations, Permits [Primary Treatment]	17 Wastewater Mathematics [Secondary Treatment]	18 Wastewater Mathematics [Secondary Treatment]	19
20	21 Math I [Secondary Treatment]	22 Math I [Secondary Treatment]	23 Math II [Secondary Treatment]	24 Math II [Secondary Treatment]	25 Physics [Secondary Treatment]	26
27	28 Physics [Secondary Treatment]	29 Physics [Secondary Treatment]	30 Physics [Secondary Treatment]	31 Wastewater Chemistry (New) [Secondary Treatment]		

Hawaii Boot Camp Day Classes
[] = indicates afternoon hands on training

February

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1 Wastewater Chemistry (New) [Secondary Treatment]	2
3	4 Wastewater Chemistry (New) [Solids Handling]	5 Wastewater Chemistry (New) [Solids Handling]	6 Wastewater Microbiology [Solids Handling]	7 Wastewater Microbiology [Solids Handling]	8 Activated Sludge Process Control [Solids Handling]	9
10	11 Activated Sludge Process Control [Solids Handling]	12 Equipment Operations [Solids Handling]	13 Equipment Operations [Solids Handling]	14 Pump controls, types, operation, and maintenance [Solids Handling]	15 Pump controls, types, operation, and maintenance [Solids Handling]	16
17	18 Sludge handling, process, treatment and disposal [Solids Handling]	19 Sludge handling, process, treatment and disposal [Solids Handling]	20 Waste treatment Processes, community wastewater system, pretreatment and clarification [Solids Handling]	21 Waste treatment Processes, community wastewater system, pretreatment and clarification [Solids Handling]	22 DRC [Sludge Handling]	23
24	25 DRC [Sludge Handling]	26	27	28		

Hawaii Boot Camp Day Classes
[] = indicates afternoon hands on training

90 Day Boot Camp Outline

Duration - 12 Weeks (5 days/week)

- Day Time Courses (4 hours/class/day):
    - Introduction
        - 101 Basic Course For Wastewater Treatment Plant Operators (3 days)
    - Safety
        - 103 Plant Safety (2 days)
        - 106 Hazard Communication Program (1 day)
        - 114 Permit-Confined Space Entry (1 day)
        - 118 First Aid and CPR (American Red Cross provides Instructor & Materials) (2 days)
    - Clean Water Act, regulations, permits (record keeping)
        - 108/112-National Pollution Discharge Elimination Systems (NPDES), UIC Permits and CWA Regulations/State Regulations Affecting WTW's Workshop (2 days)
    - Math
        - 105 Wastewater Mathematics (2 day)
        - 216 Basic Wastewater Operator Math I (2 days)
        - 217 Basic Wastewater Operator Math II (2 days)
    - Physics
        - 215 Plant Sciences (3 days)
    - Chemistry
        - 117 Wastewater Chemistry (New) (3 days)
    - Microbiology
        - 310 Activated Sludge Microbiology (2 days)
    - Electricity
        - 102 Basic Electricity Review and Reading Electrical Diagrams (2 days)
    - Collection Systems
        - 104 Wastewater Collection Systems Basic Course (2 days)
    - Treatment Methods

        - 201 Activated Sludge Process control (3 days)
        - 205 Equipment Operations – Operator Techniques & Practices, Lubrication, Heat Exchanges and Valve Operations (3 days)
        - 206 Pressure Measurement and Fluid Flow Measurement (2 days)
        - 208 Pump controls, Types, Operation, and Maintenance (3 days)
        - 210 Sludge Handling, Process, treatment and Disposal (3 days)
        - 211 Troubleshooting Pumps (3 days)
        - 214 Waste Treatment Processes, community wastewater System, Pretreatment and Clarification (3 days)
        - 220 Odor Control System (3 days)
        - 250 Mechanical Maintenance I: Air Compressors and Blowers (2 days)
        - 251 Mechanical Maintenance II: Bearings, Lubrication, Packing, and Seals (2 days)
        - 253 Mechanical Maintenance IV: Valves (2 days)

    - DRC Course (Direct Responsible Charge) (2 days)

- Afternoon Sessions – Hands on Training (3 hours per session)
    - Includes:
        - Preliminary Treatment (9 days)
        - Primary Treatment (9 days)
        - Secondary Treatment (18 days)
        - Solids Handling (24 days)
        - Process of operations, start up, shut down, and maintenance

90 Day Boot Camp Curriculum Breakdown

90 Day Boot Camp			
Course Subject	**Duration (hrs)**	**Hands On Training**	**Duration (hrs)**
Introduction to Wastewater Treatment	12	Preliminary Treatment	27
Safety	24	Primary Treatment	27
Clean Water Act, Regulations, Permits	8	Secondary Treatment	54
Math	24	Solids Handling	72
Physics	12	-	-
Chemistry	12	-	-
Microbiology	8	-	-
Electricity	8	-	-
Collection Systems	8	-	-
Treatment Methods	116	-	-
DRC (Direct Responsible Charge)	8	-	-
Total	**240**	-	**180**
Total CEU's Received	**30**	**-**	**-**

90 Day Boot Camp Courses

Day Time Courses:

- 101 Basic Course For Wastewater Treatment Plant Operators
- 103 Plant Safety
- 106 Hazard Communication Program
- 114 Permit-Confined Space Entry
- 118 First Aid and CPR (American Red Cross provides Instructor & Materials)
- 108/112 National Pollution Discharge Elimination Systems (NPDES), UIC Permits and CWA Regulations/State Regulations Affecting WTW's Workshop
- 105 Wastewater Mathematics
- 216 Basic Wastewater Operator Math I
- 217 Basic Wastewater Operator Math II
- 215 Plant Sciences
- 117 Wastewater Chemistry (New)
- 310 Activated Sludge Microbiology
- 102 Basic Electricity Review and Reading Electrical Diagrams
- 104 Wastewater Collection Systems Basic Course
- 201 Activated Sludge Process Control
- 205 Equipment Operations – Operator Techniques & Practices, Lubrication, Heat Exchanges and Valve Operations
- 206 Pressure Measurement and Fluid Flow Measurement
- 208 Pump controls, Types, Operation, and Maintenance
- 210 Sludge Handling, Process, treatment and Disposal
- 211 Troubleshooting Pumps
- 214 Waste Treatment Processes, community wastewater System, Pretreatment and Clarification
- 220 Odor Control Systems
- 250 Mechanical Maintenance I: Air Compressors and Blowers
- 251 Mechanical Maintenance II: Bearings, Lubrication, Packing, and Seals
- 253 Mechanical Maintenance IV: Valves
- DRC Course (Direct Responsible Charge)

90 Day Boot Camp Calendar

January

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1 Basic Wastewater [Preliminary Treatment]	2 Basic Wastewater [Preliminary Treatment]	3 Basic Wastewater [Preliminary Treatment]	4 Basic Safety Course [Preliminary Treatment]	5
6	7 Basic Safety Course {Preliminary Treatment]	8 Hazard Communication Program [Preliminary Treatment]	9 Permit-Confined Space Entry [Preliminary Treatment]	10 First Aid and CPR [Preliminary Treatment]	11 First Aid and CPR [Preliminary Treatment]	12
13	14 CWA, Regulations, Permits [Primary Treatment]	15 CWA, Regulations, Permits [Primary Treatment]	16 Wastewater Mathematics [Primary Treatment]	17 Wastewater Mathematics [Primary Treatment]	18 Math I [Primary Treatment]	19
20	21 Math I [Primary Treatment]	22 Math II [Primary Treatment]	23 Math II [Primary Treatment]	24 Physics [Primary Treatment]	25 Physics [Secondary Treatment]	26
27	28 Physics [Secondary Treatment]	29 Wastewater Chemistry (New) [Secondary Treatment]	30 Wastewater Chemistry (New) [Secondary Treatment]	31 Wastewater Chemistry (New) [Secondary Treatment]		

Hawaii Boot Camp Day Classes
[] = indicates afternoon hands on training

February

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1 Wastewater Microbiology [Secondary Treatment]	2
3	4 Wastewater Microbiology [Secondary Treatment]	5 Electricity [Secondary Treatment]	6 Electricity [Secondary Treatment]	7 Collection Systems [Secondary Treatment]	8 Collection Systems [Secondary Treatment]	9
10	11 Activated Sludge Process Control [Secondary Treatment]	12 Activated Sludge Process Control [Secondary Treatment]	13 Activated Sludge Process Control [Secondary Treatment]	14 Equipment Operations [Secondary Treatment]	15 Equipment Operations [Secondary Treatment]	16
17	18 Equipment Operations [Secondary Treatment]	19 Pressure and Fluid Flow [Secondary Treatment]	20 Pressure and Fluid Flow [Solids Handling]	21 Pump controls, types, operation, and maintenance [Solids Handling]	22 Pump controls, types, operation, and maintenance [Solids Handling]	23
24	25 Pump controls, types, operations, and maintenance [Solids Handling]	26 Troubleshooting Pumps [Solids Handling]	27 Troubleshooting Pumps [Solids Handling]	28 Troubleshooting Pumps [Solids Handling]		

Hawaii Boot Camp Day Classes
[] = indicates afternoon hands on training

March

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1 Sludge handling, process, treatment and disposal [Solids Handling]	2
3	4 Sludge handling, process, treatment and disposal [Solids Handling]	5 Sludge handling, process, treatment and disposal [Solids Handling]	6 Waste treatment Processes, community wastewater system, pretreatment and clarification [Solids Handling]	7 Waste treatment Processes, community wastewater system, pretreatment and clarification [Solids Handling]	8 Waste treatment Processes, community wastewater system, pretreatment and clarification [Solids Handling]	9
10	11 220 Odor Control System [Sludge Handling]	12 220 Odor Control System [Sludge Handling]	13 220 Odor Control System [Sludge Handling]	14 Mechanical Maintenance I [Sludge Handling]	15 Mechanical Maintenance I [Sludge Handling]	16
17	18 Mechanical Maintenance II [Sludge Handling]	19 Mechanical Maintenance II [Sludge Handling]	20 Mechanical Maintenance IV [Sludge Handling]	21 Mechanical Maintenance IV [Sludge Handling]	22 DRC [Sludge Handling]	23
24	25 DRC [Sludge Handling]	26	27	28	29	30
31						

Hawaii Boot Camp Day Classes
[] = indicates afternoon hands on training

Proposed Hawaii Boot Camp Course Descriptions and Potential Topics

Training Section	Course	Description	Potential Topics
Introduction To Wastewater Treatment	101 Basic Course For Wastewater Treatment Plant Operators	An overview of three main wastewater topics that include the Characteristics of Sewage, Natural Biological Treatment Processes, and Waste Treatment Methods.	Basic understanding of sewage characteristics and composition, practical background theory, and biological process involved in wastewater treatment such as aerobic and anaerobic decomposition, and aerobic, facultative, anaerobic bacteria, introductory discussions on pretreatment, primary treatment variations, and solids handling and disposal.
Plant Safety	103 Plant Safety	A course intended to educate about plant safety.	Fire safety, hazardous substance, Personal Safety, and Respiratory Protection.
	106 Hazard Communication Program	Information and training on hazardous chemicals.	Hazardous chemicals, material safety data sheets, methods and observation for detecting hazardous chemicals, physical and health hazards of chemicals, and details of the hazard communication program.
	114 Permit-Confined Space Entry	Training pertaining to safety requirements for entering and working in confined spaces.	Definition of confined spaces, prohibited conditions, mandatory training, permit requirements for confined spaces, evaluation of workplace, authorized entrants, permit system requirements of entry supervisors, and attendant information regarding must know hazards and rescue services.
	118 First Aid and CPR	First Aid and CPR Training provided by the American Red Cross	First Aid and CPR Training

Proposed Hawaii Boot Camp Course Descriptions and Potential Topics Cont'd

Training Section	Course	Description	Potential Topics
The Clean Water Act	108/112 National Pollution Discharge Elimination Systems (NPDES), UIC Permits and CWA Regulations/State Regulations Affecting WTW's Workshop	A merger of courses 108 and 112. NPDES/UIC Permit Requirements and other wastewater operation regulatory requirement instructions for operators, supervisors, and managers.	NPDES and UIC permits, The Federal Clean Water Act (CWA), applicable State of Hawaii Revised Statues and Administrative Rules pertaining to wastewater operations, and any County directives, ordinances, regulations or rules pertaining to wastewater operations.
Math	105 Wastewater Mathematics	Review of various basic and related mathematics problems encountered in everyday wastewater activities.	Various basic and related mathematics wastewater operator problems
	216 Basic Wastewater Operator Math I	Covers both elementary and basic math training that Grade I operators would be required to understand.	Basic area and volume calculations, whole numbers, decimals, scientific notation, cancellation of units, fractions, and conversion exercises
	217 Basic Wastewater Operator Math II	Covers industrial treatment math problems that are similar to certification exam questions.	Flow and detention time calculations, areas, volumes, chemical feed rates, removal rates and efficiencies, chlorination, chemical reactions, pH calculations, chemical solutions, statistical concepts, and various miscellaneous calculations.
Physics	215 Plant Sciences (Physics)	Encompasses major subject areas of plant sciences.	Science fundamentals, Properties of Matter, Heat, and Process Dynamics.
Chemistry	117 Wastewater Chemistry	Basic concepts of wastewater chemistry.	Atoms, molecules, states of matter, chemical bonding, chemical feed applications, and chemical analyses.

Proposed Hawaii Boot Camp Course Descriptions and Potential Topics Cont'd

Training Section	Course	Description	Potential Topics
Microbiology	310 Activated Sludge Microbiology	Basic functions of various microbes.	Relationship between relative predominance of organisms and condition of activated sludge.
Electricity	102 Basic Electricity Review and Reading Electrical Diagrams	Review of fundamental electrical concepts.	Basic electrical qualities, the nature of electricity, Ohm's Law, parallel and series circuits, inductance, capacitance, and electromagnetism.
Collection Systems	104 Wastewater Collection Systems Basic Course	Introduction to the maintenance and operation of wastewater collection systems.	Types of wastewater collection systems, basic components of collection systems, main types of sewers, inflow, infiltration, exfiltration, importance of dissolved oxygen and microorganisms in wastewater, and aerobic and anaerobic decomposition.

Proposed Hawaii Boot Camp Course Descriptions and Potential Topics Cont'd

Training Section	Course	Description	Potential Topics
Treatment Methods	201 Activated Sludge Process Control	Training program covering the process control in an activated sludge system.	Maintenance and knowledge of activated sludge system and identification of components of aeration and clarification methods.
	205 Equipment Operation	Basic techniques and practices involved in equipment operations.	Guidelines and safety considerations for operating equipment, making adjustments to equipment, monitoring normal operations, performing inspections, and responding to problems.
	206 Pressure Measurement and Fluid Flow Measurement	Basic concepts of pressure and fluid flow measurements.	Basic concepts of pressure, devices and instruments used to measure pressure, fundamental information on differential pressure, and fluid flow measurements.
	208 Pump Controls, Types, Operation and Maintenance	Basic components of pumps and pump processes, as wells as purpose of pumps in the wastewater field.	Basic components of the pump assembly, basic types of motors, starters and enclosures, troubleshooting, motor controls, centrifugal pumps, basic components of centrifugal pumps, control of centrifugal pumps, positive displacement pumps, and basic components of positive displacement pumps.
	210 Sludge Handling, Process, Treatment, and Disposal	Covers the basics of wastewater sludge.	Creation of sludge, the thickening of sludge, the processing of sludge, aerobic and anaerobic digestion, and control and operational control procedures in sludge dewatering.

Proposed Hawaii Boot Camp Course Descriptions and Potential Topics Cont'd

	Training Section	Course	Description
Treatment Methods Cont'd	211 Troubleshooting Pumps	Covers the basics of normal equipment operations and backgrounds	Positive displacement pumps, centrifugal pumps, and reciprocating air compressors and pumping principles
	214 Waste Treatment Processes, Community wastewater System, Pre-treatment, and Clarification	Continuation of 101 Basic Course comprising of 4 sections.	Recap of the composition of normal domestic wastewater, necessity and importance of treating it, the overall picture of wastewater treatment, discussions on pretreatment, clarification, sludge, and scum removal equipment, etc., as well as wastewater collection, primary treatment, intermediate, and secondary treatment.
	220 Odor Control System	Overview of odor control systems and related topics	Odor control, public relations, health and safety issues, measurement and generation of odors, treatment technologies, source control and containment, systematic odor control strategy, case histories, and a site visit.

Proposed Hawaii Boot Camp Course Descriptions and Potential Topics Cont'd

	Training Section	Course	Description
Treatment Methods Cont'd	250 Mechanical Maintenance I: Air Compressors and Blowers	Covers procedures for air compressor and blower maintenance	Basics, removal, and disassembly of reciprocating air compressors, suction valve unloaders, and rotary blowers.
	251 Mechanical Maintenance II: Bearings, Lubrication, Packing, and Seals	Covers mechanical maintenance procedures for bearings and lubrication as well as packing and seals.	Introduction to various types of bearings, maintenance, disassembly procedures, packing removal and installation, and removal, disassembly, and inspection of various mechanical seals.
	253 Mechanical Maintenance IV: Valves	Covers mechanical maintenance for various types of valves.	Construction, disassembly, inspection, reassembly, and installation of various types of valves.
Direct Responsible Charge	DRC	Plant responsibilities of a wastewater operator	TBD

Appendix H: Proposed Hawaii Wastewater Operator Career Brochure

Additional Information

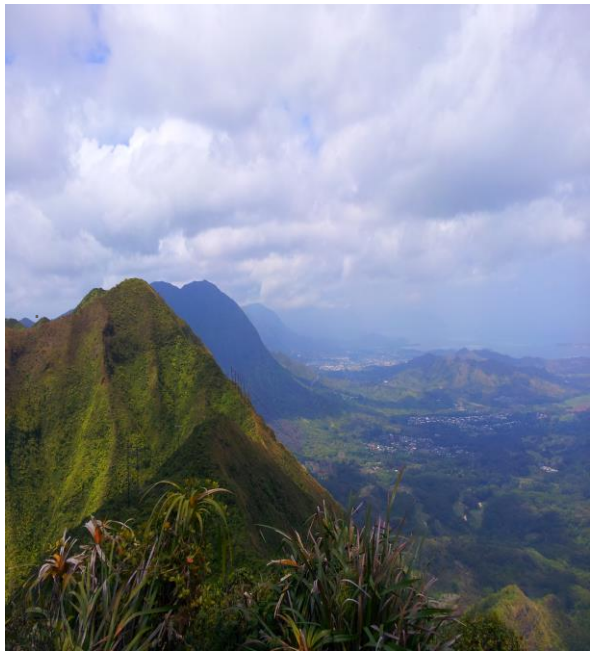
Wastewater operators are an essential facet to the wellbeing of the public health. If you are interesting in becoming an operator, as well as obtianing more information regarding wastewater operators visit:

http://hawaii.gov/health/environmental/water/wastewater/sotc.html

Hawaii Wastewater Operator Career Program

Protecting The Environment

Why Become an Operator?



Why?
Wastewater Treatment Plant Operators are incredibly important and vital for maintaining an environmentally safe environment. Wastewater treatment plants are utilized to safely and effectively, remove contaminants from wastewater. Wastewater can be generated from a variety of origins including household wastes from toilets, showers, baths, and kitchen sinks as well as from work facilities. Such processes of treatment can comprise of physical, chemical, and biological methods. The main purpose of a wastewater treatment plant is to create effluent, or discharge, that is environmentally safe. Operators play a pivotal role in such processes and provide communities with an incredibly important service.

Requirements
There are various levels of operator certification that range from Grade's 1 to 4. At all levels of certification, a minimum of a high school diploma or equivalent is required. Working operator experience is also necessary as well and can vary depending on pre-certification continuing education units (CEU's) that can be obtained through completion of training courses. There are numerous training courses offered by Hawaii's Statewide Wastewater Operator Training Center that can be used to fulfill CEU requirements as well as provide instrumental knowledge necessary for passing certification exams.

Grade Level	Experience	CEU's
1	1	0
2	2	6
3	3	16
4	4	48

Training
Wastewater operators can encounter numerous tasks, problems, and scenarios on a daily basis. It is important that operators obtain competence in a wide range of wastewater topics including equipment operations, monitoring, evaluating, & adjusting treatment processes, characteristics of wastestream, and safety precautions. Not only does training aid in meeting minimum CEU requirements, it also enables applicants to prepare for certification exams as well.

Benefits
The pay rates of wastewater operators can range from approximately $3,853/month for Grade I level operators to $4,298/month for Grade 4 level operators! In addition, wastewater operators would also be providing the public communities with an environmentally safe environment to live in.

Grade Level	Pay Rate
1	$3,853/month
2	$3,994/month
3	$4,147/month
4	$4,298/month

"Be the future you seek to see."

Appendix I: Oahu Wastewater Operator Survey Results

Oahu Wastewater Operator Survey Results

Location of Survey	Current Age	Year Started Working	Years of Service	Expected Retirement Age	Years of Work Remaining
Sand Island	61	1993	20	Undecided	Unknown
	40	2008	5	65+	25
	41	2010	3	65+	24
	58	1985	28	65+	7
	50	2009	4	65+	15
	32	2012	1	Undecided	Unknown
	52	2007	6	65+	13
	45	2006	7	67+	22
	60	1998	15	65+	5
	54	2009	4	65+	11
	40	2006	7	65+	25
	46	2001	12	69	23
	54	1989	24	65	11
	58	1992	21	62	4
Paalaa Kai	49	1987	26	56	7
	66	1987	26	67	1
Wahiawa	59	1987	25	65	6
	55	1989	24	66	11
	39	2011	1	68	29
	44	1995	18	56	12
	60	1986	27	66	6
Waianae	54	1988	24	62	8
	47	1993	21	56	9
	49	1992	21	60	11
	51	1994	19	60	9
	36	2010	2	Undecided	Unknown
	63	1996	17	74	11
	50	2010	2	68	18

Total Survey Statistics

Average Operator Age	Average Years of Service	Average Retirement Age	Expected to Retire in less than 10 years	Expect to Retire in 15 or less years
50.5	14.6	64.3	40%	72%

Appendix J: ABC Need-To-Know Criteria

ABC Need-To-Know Certification Exam Content Percentages

Major Topics	Class 1	Class 2	Class 3	Class 4
Evaluate Physical Characteristics of Wastestream	5%	6%	5%	5%
Perform Security, Safety, & Administrative Procedures	11%	11%	10%	10%
Evaluate and Maintain Equipment	28%	28%	27%	27%
Operate Equipment	16%	16%	16%	16%
Monitor, Evaluate, & Adjust Treatment Processes	33%	32%	35%	35%
Laboratory Analysis	7%	7%	7%	7%

Works Cited

1. "Activated Sludge Wastewater Treatment Process", <http://etc.morrisville.edu/coursedetails.aspx?courseid=7> (March 21, 2013)
2. "Advanced Wastewater Operations Course", <http://www.nj.gov/dep/exams/docs/COURSE%20OUTLINE-Advanced%20Wastewater%20Operations.pdf> (Feb. 5, 2013)
3. (2012). "Advanced Waste Treatment", <http://www.owp.csus.edu/courses/wastewater/advanced-waste-treatment.php> (March 22, 2013)
4. (2012). "Association of Boards of Certification Need-To-Know Criteria", <http://www.abccert.org/pdf_docs/WastewaterTreatmentNeed-to-KnowFinal2012.pdf> (Feb. 20, 2013)
5. Babcock, Roger (2013). "2012 BOC Annual Report"
6. Baker, Jonathan, (2013). "Wastewater Operator Pay Scales" (April 6, 2013)
7. Baker, Jonathan, (2013). "Wastewater Operator Survey Results" (April 6, 2013)
8. "Basic Laboratory Procedures", <http://etc.morrisville.edu/coursedetails.aspx?courseid=2> (March 21, 2013)
9. "Basic Operations of Wastewater Treatment Plants", <http://etc.morrisville.edu/coursedetails.aspx?courseid=1> (March 21, 2013)
10. "Board of Certification of Operating Personnel in Wastewater Treatment Facilities", May 22, 2009.
11. "City and County of Honolulu Wastewater Treatment and Disposal Operator Training Development Program Minute Notes", August 24, 2011.
12. (2002-2013). "City and County of Honolulu Wastewater Treatment Plants",
13. <http://www1.honolulu.gov/env/wwm/plants/index.htm> (April 9, 2013)
14. (2008). Clifton, Jim, "Wastewater Treatment Plant Operation, Class C" <https://docs.google.com/viewer?a=v&q=cache:sIo8pjXK4DQJ:apps.dce.ufl.edu/RMS/Courses/getFile.aspx%3Fg%3Dae4f2680-4810-43be-ad26-dd49415b071f%26u%3D85276%26f%3D89821+&hl=en&gl=us&pid=bl&srcid=ADGESi9y1wZKwnQKNoMxerY-5ZwmoL7d0K8-iYtZe3tSQuMyJl-CRLZQ0dkBtL0R2ISyfmhcsfElyhbWRv9qbixiiOmFVsaKEBJS5XDDV8dfGDVPTSUXYVh23YwBBjPIvoatlGya4ng&sig=AHIEtbToLYtmqBVxNOWBBk_dDWoZPShr2w> (March 22, 2013)
15. "Continuing Education Program", <http://www.wef.org/ContinuingEducation/> (Feb. 12, 2013)
16. "Department of Health Amendment and Compilation of Chapter 11-61 Hawaii Administrative Rules", <http://gen.doh.hawaii.gov/sites/har/AdmRules1/11-61.pdf> (March 27, 2013)
17. "Introduction To Water/Wastewater Operation Course", <http://www.nj.gov/dep/exams/docs/COURSE%20OUTLINE-Introduction%20to%20W&WW%20operation.pdf> (Feb. 5, 2013)
18. "Fall 2012/Spring 2013 Water/Wastewater Operators Course", <http://www.nj.gov/dep/exams/docs/Courselist.pdf>, (March 26, 2013)
19. "Georgia Wastewater Operator Training Courses", <http://gwwi.org/Wastewater.htm>, (April 16, 2012)

20. "Georgia Wastewater Operator Rules", <http://rules.sos.state.ga.us/docs/750/3/04.pdf> (March 26, 2013)
21. "Grade 3 Supervision and Technical Operations", <http://etc.morrisville.edu/coursedetails.aspx?courseid=8> (March 21, 2013)
22. "Grade 3 Technical Module", <http://etc.morrisville.edu/coursedetails.aspx?courseid=19> (March 21, 2013)
23. "Grade 3 Technical Module", <http://nywea.org/opcert/uploads/Spring%202013%20WW%20Class%20flyer.pdf> (April 6, 2013)
24. "Grade 4 Management", <http://etc.morrisville.edu/coursedetails.aspx?courseid=9> (March 21, 2013)
25. "Hawaii Wastewater Operator Training Courses", <http://gen.doh.hawaii.gov/sites/har/AdmRules1/11-61.pdf>, (April 3, 2012)
26. (2002-2013). "Honouliuli Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/honouliuli.htm> (April 9, 2013)
27. "Instruction Sheet For Application For Certificate of Achievement", <http://hawaii.gov/health/environmental/water/wastewater/pdf/tc1.pdf> (April 3, 2013)
28. (2002-2013). "Kailua Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/kailua.htm> (April 9, 2013)
29. (2002-2013). "Kahuku Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/kahuku.htm> (April 9, 2013)
30. Lacey, Marcia, (2008). "A Regulator's Perspective on Workforce Issues: Water and Wastewater Operators", *Journal of American Water Works Association*, 100 (8), pg.132-135.
31. (2002-2013). "Laie Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/laie.htm> (April 9, 2013)
32. Muga, Helen E., Mihelcic, James R. (2008). "Sustainability of Wastewater Treatment", *Journal of Environmental Management*, 88, pg. 437-447.
33. (2012). "Operation of Wastewater Treatment Plants, Volume I", <http://www.owp.csus.edu/courses/wastewater/operation-of-wastewater-treatment-plants-vol-i.php> (March 21, 2013)
34. (2012). "Operation of Wastewater Treatment Plants, Volume II", <http://www.owp.csus.edu/courses/wastewater/operation-of-wastewater-treatment-plants-vol-ii.php> (March 21, 2013)
35. "Operator Certification Wastewater Training Directory", <http://www.swrcb.ca.gov/water_issues/programs/operator_certification/docs/trngdir.pdf > (March 18, 2013)
36. (2013) "Operator-In-Training (OIT)", http://www.waterboards.ca.gov/water_issues/programs/operator_certification/oit_info.shtml (March 12, 2013)
37. (2002-2013). "Paalaa Kai Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/paalaakai.htm> (April 9, 2013)
38. "Requirements for Wastewater Treatment Plant Operator Certification", <http://www.dec.ny.gov/chemical/23831.html>, (March 22, 2013)

39. "Requirements Wastewater Treatment Plant Operator Certification", <http://www.waterboards.ca.gov/water_issues/programs/operator_certification/docs/req_by_grade_cert102009.pdf> (March 22, 2013)
40. "Rules and Regulations Governing the Licensing of Water Supply and Wastewater Treatment System Operators N.J.A.C. 7:10A", New Jersey Department of Environmental Protection, <http://www.nj.gov/dep/rules/rules/njac7_10a.pdf> (March. 26, 2013)
41. Salas, Wayne, (2013). Phone Interview (April 4, 2013)
42. (2002-2013). "Sand Island Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/sandisland.htm> (April 9, 2013)
43. "Sewage Treatment", <http://en.wikipedia.org/wiki/Sewage_treatment> (Jan. 7, 2013)
44. (2002 – 2013). "Wastewater Treatment Process", <http://www1.honolulu.gov/env/wwm/how_it_works.htm> (Jan. 7, 2013)
45. (2012). "Small Wastewater System Operation and Maintenance, Volume I", <http://www.owp.csus.edu/courses/wastewater/small-wastewater-system-operation-and-maintenance-vol-i.php> (March 21, 2013)
46. (2012). "Small Wastewater System Operation and Maintenance, Volume II", <http://www.owp.csus.edu/courses/wastewater/small-wastewater-system-operation-and-maintenance-vol-ii.php> (March 21, 2013)
47. Snow, Madeline, Mutschler, Deborah (May 2012). "Promoting Entry to career Pathways in the Drinking Water and Wastewater Sector", <http://www.skill-works.org/documents/DrinkingWaterandWastewaterReport_web_May2012.pdf> (April 4, 2013)
48. "Statewide Wastewater Operator Training Center", <http://hawaii.gov/health/environmental/water/wastewater/sotc.html>, (April 5, 2013)
49. "Steps to Obtaining a GA Wastewater Treatment Operator License", <http://www.gecap.org/pdf/How_to_Get_GA_WW_Operator_Certified.pdf> (March 26, 2013)
50. Tomboc, Hermen, (2013). Interview (April 6, 2013)
51. (2002-2013). "Wahiawa Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/wahiawa.htm> (April 9, 2013)
52. (2002-2013). "Waianae Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/waianae.htm> (April 9, 2013)
53. (2002-2013). "Waimanalo Wastewater Treatment Plant", <http://www1.honolulu.gov/env/wwm/plants/waimanalo.htm> (April 9, 2013)
54. (1996-2011). "Water Supply & Wastewater Treatment System Operators Licensing", <http://www.nj.gov/dep/exams/wsw.htm> (Feb. 5, 2013)
55. (2002 – 2012). "Wastewater Operators", <http://www.tceq.texas.gov/licensing/licenses/wwlic#treatcourses> (March 22, 2013)
56. (2002 – 2013). "Wastewater Treatment Plants Oahu", <http://www1.honolulu.gov/env/wwm/plants/index.htm> (Oct. 11, 2012)
57. (2012). "Wastewater Treatment Plant Operation Specialist Certificate", <http://www.owp.csus.edu/courses/wastewater-specialist.php> (March 17, 2013)
58. "Water and Wastewater Operators", <http://www.health.ny.gov/environmental/water/drinking/operate/docs/opcareer.pdf> (April 5, 2013)